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IN THIS ISSUE:

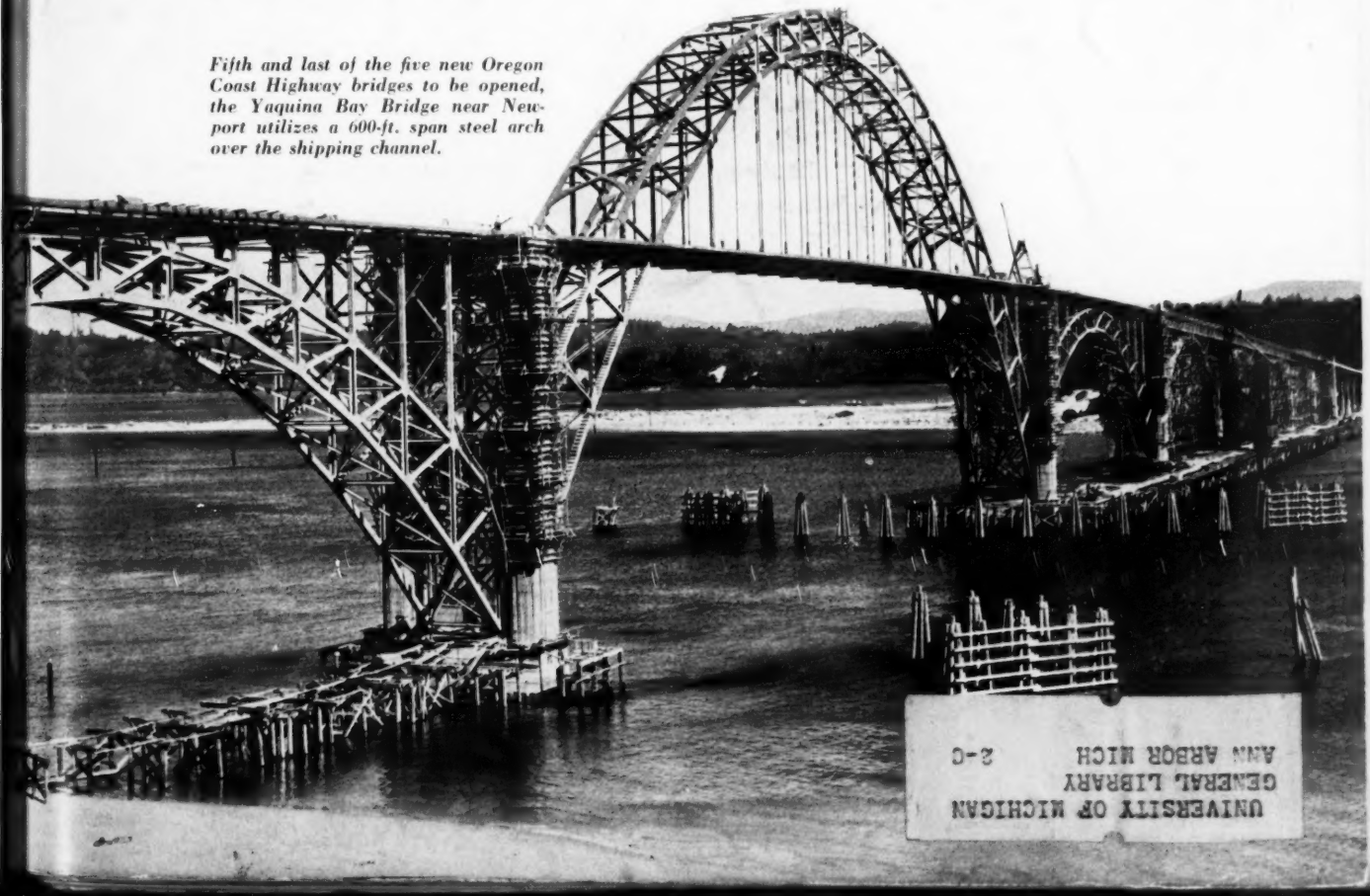
Four Water Supply Articles

INCLUDING

The Decline of Typhoid · by M. N. Baker

ALSO:

Report of Conferences on World Power and Large Dams



Fifth and last of the five new Oregon Coast Highway bridges to be opened, the Yaquina Bay Bridge near Newport utilizes a 600-ft. span steel arch over the shipping channel.

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As We Enter a SELLER'S MARKET

ALL about us the chart-hounds acclaim business recovery. The statistics and other economic yardsticks that are accepted as the material measures of business activity are on the up and up.

But there are other indexes of equal eloquence that touch more intimately the nerves of the man on the street. No longer, for example, is it so easy to get two on the center aisle; lower berths are occupied only by those of foresight; an airy room on the quiet side cannot be had for the asking. The room clerk's "Have you a reservation?" no longer is mere routine. In other words, it is more difficult to get just *what* you want, *as* you want it, *when* you want it.

IN even more subtle fashion is revival evident. With the swing of the business cycle, the attitudes of buyer and seller are changing; once again the seller is coming to be top dog. Sensing this, he is beginning in some cases to snarl a little and show his teeth. They are not pretty teeth.

For example: Recently a business traveller asked of a prominent hotel that he has patronized for years, an hour's leeway beyond the regular checking-out time. Two years ago such a courtesy would have been granted cordially by any room clerk. Then, customer good will was an asset—something to be sought, cultivated and valued. But these are other days. A frosty assistant manager, to whom the guest was referred, was the soul of condescension. He granted the request, but only after he had put the guest on the spot as asking for something quite out of order. The intimation was clear that, even though he might be favored this time, he should think twice before again seeking such a concession.

Now all this is not to contend that the hotel was *not* full, or that people were *not* waiting for rooms. Possibly the request *was* entirely out of order. This comment is directed not to the action itself but wholly to the manner. It would have been perfectly possible to have declined the request altogether and leave a good taste; but although the request was granted, a bad taste was left. It was altogether a matter of manner.

But the manner is born of the spirit and such a change of attitude betokens a change of spirit. A few years ago every buyer was a king. Of necessity the seller exerted himself to win his good will and favor. To do that no concession was too great. All this, perhaps, was not too easy on the seller; now, with things coming his way, he may be inclined to get back some of his own. Not deliberately and intentionally perhaps, but none the less naturally enough.

Anyone can understand that. But, after all, may not the same gracious attitude toward a customer that may have been considered necessary then, be equally profitable today? Is it not possible that in good times a cordial, helpful spirit may help to sustain an uptrend just as effectively as it helped to stem a slump? Under the pressure of more volume, sellers may have to disappoint buyers more often than they used to; it is quite possible that "the voice with a smile" may be the more acceptable to a disappointed customer even though it must say no to him.

THE fact that some sellers are setting less store by good will may be a sign of returning prosperity. But it is a sign also that they have learned little from their adversity. The most precious and most perishable asset of any business is its good will. Many concerns, both great and small, cultivate it consistently through the quality of their products, of their service, of their advertising and of their sales methods, as all these may interpret their attitude toward their customers.

In good times or bad, a considerate and helpful attitude always is in order. If we can say yes to a customer, it makes him the more appreciative of our assent; if, unfortunately, we *must* say no, it makes him the less resentful of the denial.

Willard Chevalier

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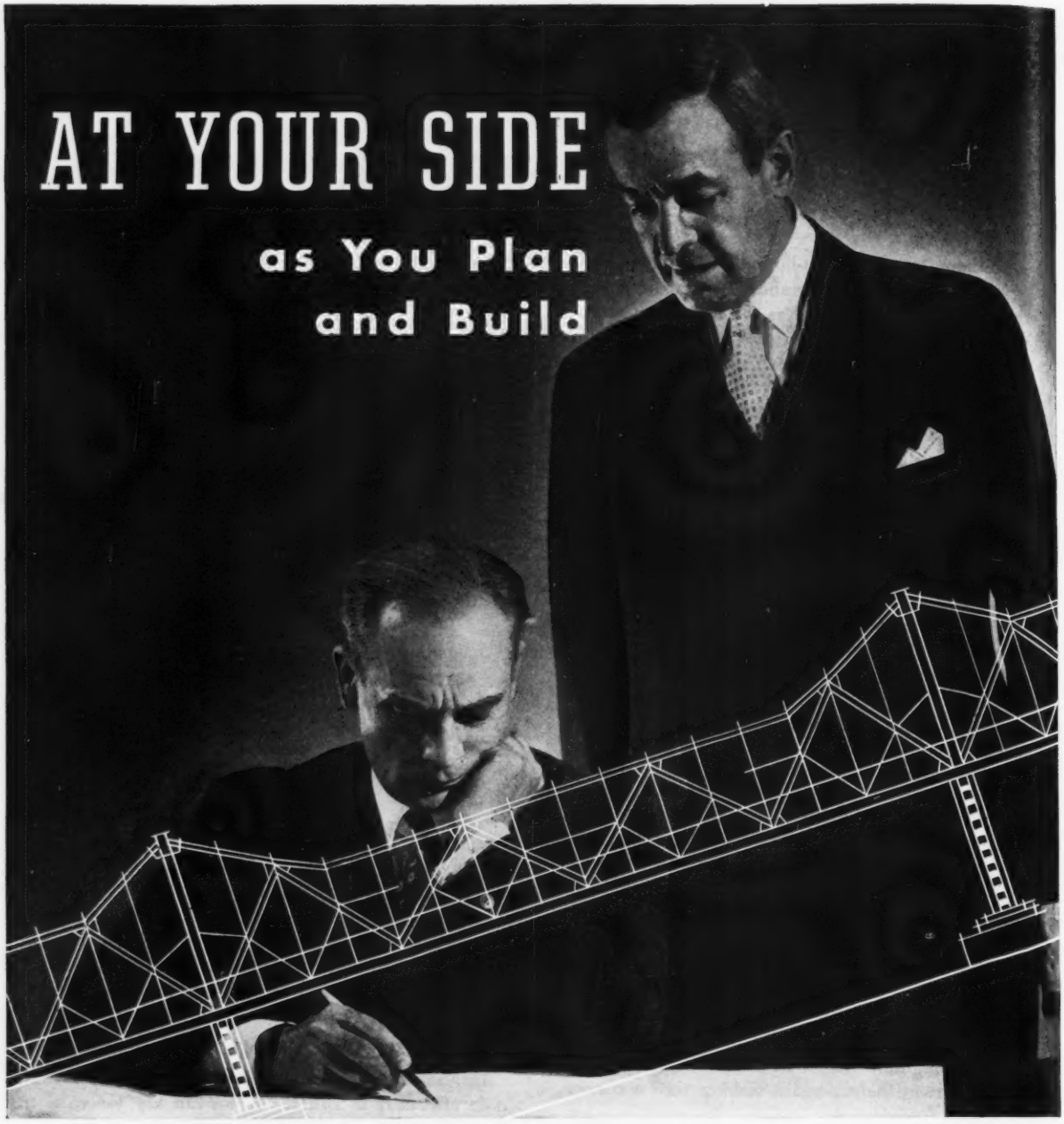

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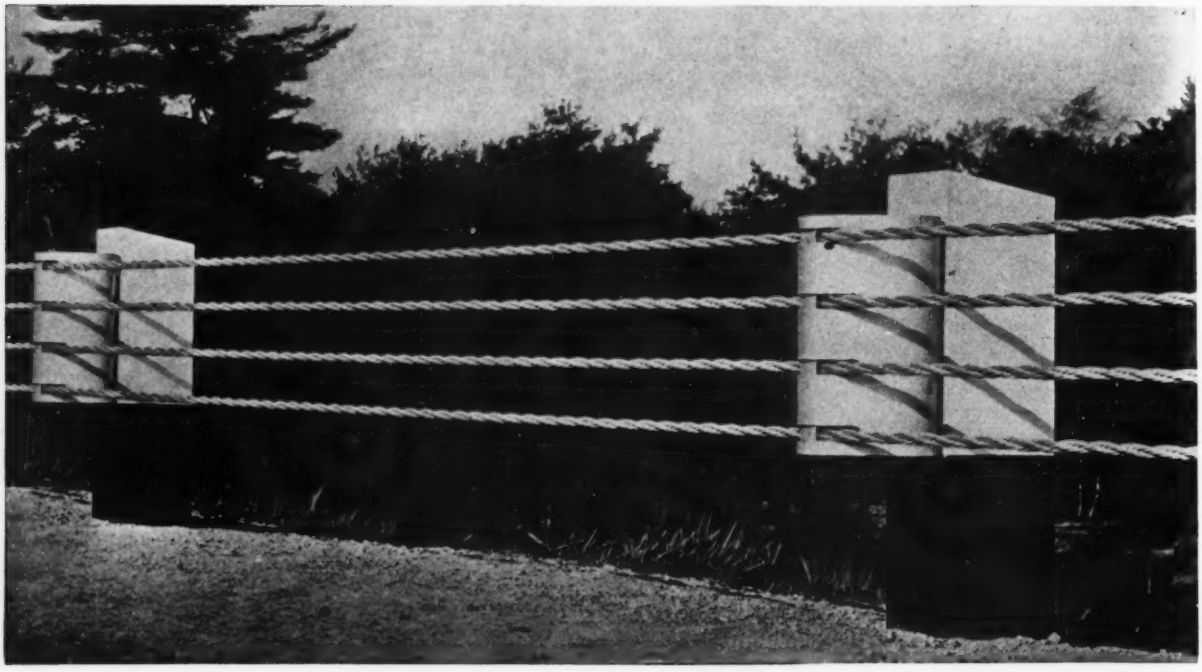
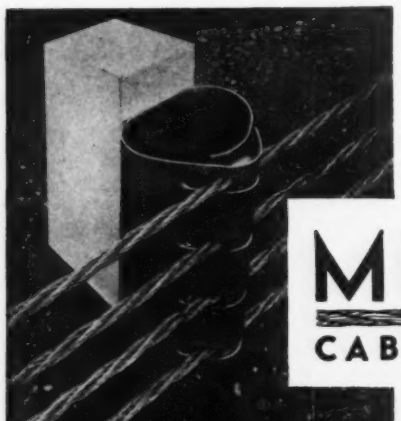
■

Municipal Problems—TWO WEEKS HENCE, Toronto will be host to the American Society of Municipal Engineers and the International Association of Public Works Officials. NEXT WEEK, *News-Record* takes special note of the many problems that beset city engineers by presenting a group of articles on municipal modernization, sewage treatment, incineration, paving, air conditioning, drainage, surveying, flood protection and traffic control.

Safeguarding
A NATION'S HIGHWAYS



DON'T take any chances. Put your trust in Multisafty Cable Highway Guard. Tests and actual use have convincingly demonstrated its superiority in preventing injury or damage either to the vehicle or guard itself. Here's the reason.



The two cable highway guard, in general use throughout the country today, was a distinct advance over earlier guards. But the present day speed of motor travel demands the even greater protection of Multisafty Cable Highway Guard. This new construction capitalizes on the inherent strength of wire cable composed of a plurality of steel wires of high tensile strength — increases the safety value of the whole structure.

Besides, there is a vital improvement in the off-set spring post bracket. This bracket, strong, tough, as resilient as a spring, acts as a buffer between the cables and the post, absorbs the shock of impact, eliminates the danger of post collision and reduces post breakage.

Modern in every detail, Multisafty Cable Highway Guard insures new flexibility in construction. You can choose a rail member having three, four or more cables. You can install Multisafty to conform to curving alignment, or change in grade. You can space posts to avoid rocks or other obstructions. Yes—and installation is simple, too—common labor and a few ordinary tools will do the job.

Don't neglect to send for the new booklet, "Guardian of the Highways." Here are complete facts about Multisafty — its performance record — its adaptability to your highway needs. A postcard brings it to you.

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UNITED STATES STEEL

ENGINEERING NEWS-RECORD

September 17, 1936

FIG. 1—DETROIT'S great Springwells pumping station which is now in complete service.

Detroit Tunes Up Its Springwells Pumping Plant

By B. J. Mullen

Chief Plant Operator, Department of Water Supply Detroit, Mich.

DUE TO THE DEPRESSION the great Springwells plant of the Detroit water supply was not needed and so was held out of service until 1935—four years after it was essentially completed. Designed to serve 1,500,000 people, this wholly new station has a modern turbo-electric generating plant to operate its sixteen high, intermediate, and low-lift pumps which have a combined capacity of 568 m.g.d. Acceptance tests had to be made under operating conditions. Both power plant and pumping plant represent the last word in flexibility of operation, safety against emergencies and general efficiency, results that are largely achieved through a multiplicity of gages, meters, switchboards, remote controls and indicating devices. It is the purpose of this article, after a brief description of the pumping and power plants, to describe the tuning-up process, the pump-acceptance-test procedure, the intricate gage and meter calibrations and certain of the difficulties encountered.

—EDITOR

THE Springwells pumping station, built as part of a large additional water supply development to furnish water for North and West Detroit and adjoining municipalities, occupies a 40-acre site located just outside of the Detroit city limits in Dearborn, Mich. It takes water from the Detroit River, utilizing the intake system at the head of Belle Isle which also supplies water to the older or Water Works Park station. Springwells station is 12 miles distant from the river intake, and water to the station flows by gravity through a concrete tunnel from 12 to 15½ ft. in diameter. On the 40-acre site of the station are located a filtration plant, clear-water reservoirs, low and high-lift pumping plants, power plant and storage building and coal-storage pit. Excavation for subgrade structures was required over 21.6 acres or 54 per cent of the site. Building superstructures occupy 13.3 per cent of the site area.

The station was designed to deliver filtered water to the distribution system at an average day rate of 206 m.g.d., a maximum day rate of 300 m.g.d. and a maximum hour rate ranging from 380 to 400 m.g.d.

The low-lift pumping plant, which delivers all water from the river tunnel, has a total installed pumping capacity of 435 m.g.d. The equipment consists of ten pumping units. Six 60-m.g.d. vertical-shaft centrifugal pumps are direct connected to 750-hp. vertical, separately excited, synchronous motors; the casings of each of these pumps are identical but three are equipped with impellers to develop a rated head of 60 ft. and three with impellers to develop a rated head of 50 ft. Two 30-m.g.d. vertical-shaft pumps of 50-ft. rated head are direct connected to 350-hp. slip-ring induction motors arranged for graduated speed reduction which provides a minimum pump capacity of 15 m.g.d. Two 7.5-m.g.d. vertical centrifugal pumps are direct connected to two-speed 100-200-hp. induction motors. These pumps may be used to pump water to the filtration plant, to dewater the 12-mile tunnel or to dewater the plant pump pit in case of an emergency, such as might be occasioned from a break in a pump casing or in one of the cast-iron water lines in the plant.

The high-lift pumping plant, which delivers water to the city distribution system, has an installed pumping capacity of 568 m.g.d. The final installed capacity is scheduled to be 680 m.g.d. In this plant there are sixteen horizontal centrifugal pumping units, eight of which are located on each side of the pumping-plant building. Those on the side with a rated capacity of 254 m.g.d. against a head of 200 ft. deliver water to high north, northwest and west portions of the city and adjoining municipalities. In these eight units are four 40-m.g.d. pumps direct connected to 1,725-hp. synchronous motors, two 17-m.g.d. pumps direct connected to 700-hp. synchronous motors, and two 30-m.g.d. pumps direct connected

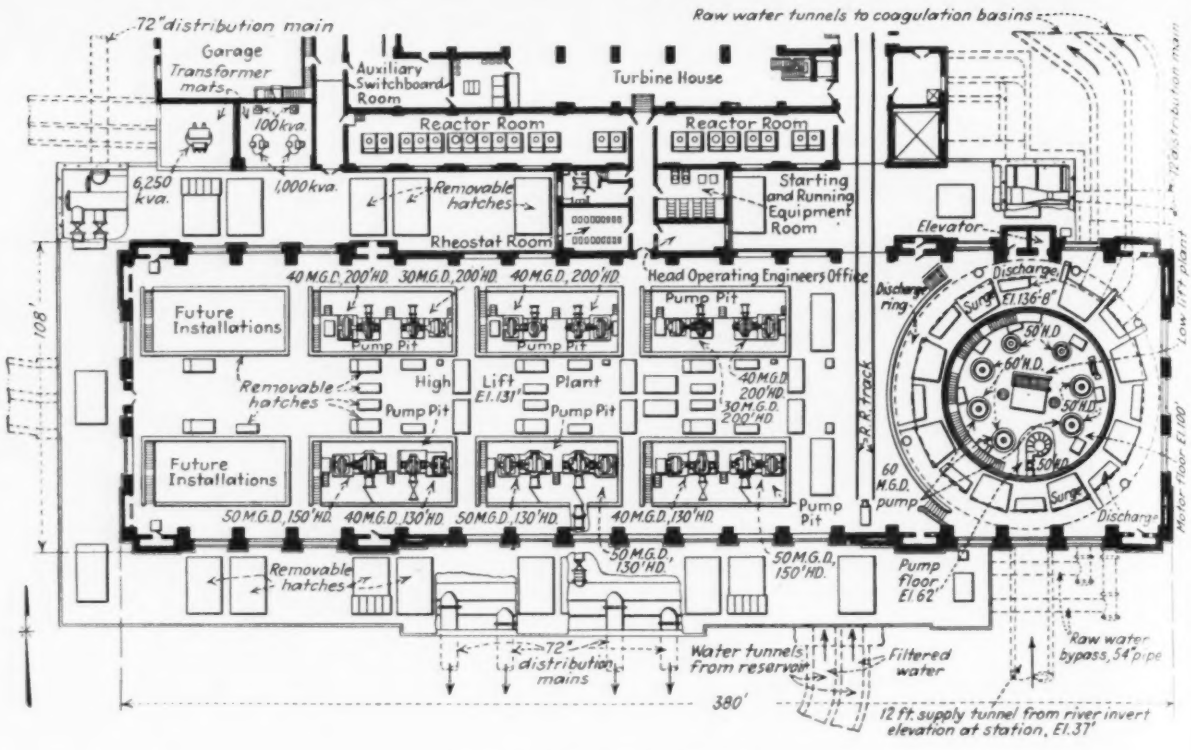


FIG. 2—LAYOUT of the Springwells Station which in effect combines three pumping plants. The low-lift plant for raw water is arranged in a circular pit; the high-lift plant for filtered water is divided to supply high- and low-service systems in the city.

to 1,400-hp. slip-ring variable-speed induction motors. The other eight units on the other side of the plant, with a total rated capacity of 314 m.g.d. against heads of 130 or 150-ft., deliver water to the lower west and south portions of the city and surburbs. In these eight units there are four 50-m.g.d. pumps direct connected to 1,400 to 1,600-hp. synchronous motors, two 17-m.g.d. pumps direct connected to 700-hp. synchronous motors and two 40-m.g.d. pumps direct connected to 1,200 hp. variable-speed slip-ring induction motors.

All pumps in the high-lift plant are of the vertical-suction horizontal discharge type, installed in pairs in an individual pit to isolate them from other units if flooded through an emergency break in the mains or other accident. Suction pipe lines are especially designed with bell inlets. The suction well receives its supply direct from the filter plant at a high elevation if the filtration rate is greater than the pumpage rate. If the pumpage rate exceeds the filtering rate some of the pumping units take their suction direct from the filters at high elevation while the remainder take suction from the storage reservoirs at varying lower elevations. All pumps discharge horizontally through special electrically and hydraulically controlled check valves in the pump pit. After entering the pipe vault the discharge is divided into two lines, each equipped with 42-in. hydraulically operated gate valves before delivering to either one or both of two 72-in. steel lines. These lines are located on each side of the plant and have all valved inlet connections housed in a vault surrounding the plant, to form a duplicate distribution pipe system in the plant and in the station grounds, either part of which can be in service while the other is out of service for inspection or repair. Normally both lines are kept in service.

For plans of pumping station and methods of selecting the equipment see *ENR* Mar. 19, 1931, p. 468; Oct. 12 and 19, 1933, pp. 429 and 467.

The power plant

The Springwells power plant was designed to produce electric energy sufficient for all water pumping requirements and for all station auxiliary power and lighting. Structures are built complete to house four main turbine generators of 25,000-kw. total capacity, four auxiliary turbine generators of 2,000-kw. total capacity and four boiler units of 4,000-hp. or more total capacity. Equipment actually installed includes two 5,000-kw. main turbine generators with complete auxiliary equipment arranged for two-stage bleeding for feedwater heating, three 500-kw. auxiliary turbine generators with complete auxiliary equipment and arranged for one-stage bleeding for station heating, two 1,000-hp. boilers including stokers, forced and induced-draft fans, economizers, superheaters and air preheaters. Boiler units deliver 700-deg. F. steam at a pressure of 350 lb., which steam is used for operation of both main and auxiliary turbines. Main turbine generators deliver 4,600-volt, 60-cycle electric energy which is used for operation of all major pump motors. Auxiliary turbine generators deliver 460-volt, 60-cycle, electric energy which is used for station lighting and auxiliary power, a portion of the output being converted into d.c. energy to operate a large percentage of the auxiliary equipment in the power plant, such as stokers, forced and induced-draft fans and ventilating fans, circulating hot-well and boiler-feed pumps. Circulating water for condensers is taken from and returned to either one of two water conduits delivering unfiltered, intermittently chlorinated, water from the low-lift plant to the filtration plant. Condensate from all turbines, station-heating system and evaporated makeup is deaerated in the shell of the main condensers, heated and again fed to the boilers. Station-heating returns are used to assist in heating the feed water.

Coal is received at the power plant either by rail or truck and is crushed and transported either to the bunkers over the boilers or to the storage pit by means of a motor-operated apron feeder, bucket elevator and belt over the bunkers, or through an inclined spout to storage. The coal may be either piled in storage pits of 18,000-ton capacity or reclaimed from the pit to the conveyor system by means of a motor-operated

drag-scraper system. Ash is sluiced from the storage hoppers under the boilers to a clinker grinder which delivers water and ash to the suction pit of two motor-driven ash pumps. These pumps deliver the ash to the storage bin about 65 ft. above the pumps where the water is allowed to drain to the sewer and the ash is then delivered through bottom gates to trucks.

The 12-mile tunnel to the Springwells station which had been completed for some time was filled with water June 18, 1931. The substructures of the low and high-lift pumping plants were constructed adjacent to each other with a single superstructure. These structures, including the installation of the equipment, with the exception of the electrical power lines and control equipment, were practically complete in August, 1931. Temporary power lines were installed for two 60-m.g.d. pumps in the low-lift plant and these pumps and a portion of the filtration plant were placed in operation Oct. 5, 1931. The output of the station, which was operated only about 8 hr. per day, was delivered to the distribution system by temporary high-lift pumping units housed in a separate temporary structure. With the station thus equipped to assist the Water Works Park station, the load was satisfactorily carried through the depression years. Due to the curtailment of contract work and personnel, slow progress was being made in completing the pumping and power plants. Practically all construction and installation work was completed by the end of 1934 and on Feb. 13, 1935, the station was placed on a 24-hr.-per-day schedule with the power plant furnishing power for water pumping.

During the interval from 1932 to 1935 a great amount of trial operation and many test runs were made on the electrical and mechanical equipment. Since all large pump motors and a portion of the auxiliary equipment and valves in both pumping plants are controlled from one remote switchboard, a great amount of check and trial operation was necessary in connection with the power and control cables and wiring, oil circuit breakers, reacters, relays, contacters, resisters, rheostats and electric instruments and gages. Tests made to determine the surge of water in the 12-mile tunnel, which would result from power failure to the low-lift plant motor-driven pumps, gave results that compared favorably with the design figures, which were determined not only theoretically but also experimentally from small model tests of the water tunnel system.

Acceptance tests

All pumping units in both plants were purchased on contracts carrying a bonus-and-penalty clause. The low bidder on each contract was determined by an adjustment of the bidder's quoted price for equipment up or down in accord with an evaluation of the efficiencies over a wide range of head guaranteed by the bidder as compared with the base overall efficiency set up in the contract. On account of this stipulation, it was found necessary to run acceptance tests carefully for each individual pumping unit. This test work ran through a period of considerably more than a year. Many preliminary tests were made, particularly in the low-lift plant, before methods acceptable to both manufacturer and city were agreed upon for measurement of power, head and capacity. In some instances, due to results of the preliminary tests, the manufacturer was asked or allowed to make slight changes in a pump before running the final acceptance tests. For example, it was found extremely difficult to measure accurately the head developed by the low-lift plant pumps in their final setting. These pumps, which were rated at 60-m.g.d. at 50-ft. head are large capacity low-head units and even under a very constant high-suction head of 20 ft. the discharge pressure was at times observed to fluctuate as much as 3 ft. This variation simply meant that long runs and frequent readings were necessary to determine correct average results. This was done carefully because it was early determined that an error of as little as 3 in. in either direction, all other test measurements able bonus or penalty on one of these units. Heads on these low-lift pumps were determined from actual water column elevations in a tube leading from a pipe pressure ring connected at four points to the pump suction and discharge. These tubes were kept absolutely free of any accumulation of air. Similarly in tests of the high-lift pumping units discharge heads were measured by means of a mercury column. In no instance were bourdon pressure gages used to determine heads developed by pumps. Capacities of all units were measured by specially designed and favorably located venturi tubes and manometers in which liquids were used having a density of from 1.25 to 2.00 so that large and easily readable deflections were obtained. Similarly in the case of the power determination, calibrated watt-hour meters, selected to give a maximum of accuracy, were used. A rotating standard meter was always connected and read simultaneously as a check on the watt-hour meter readings.

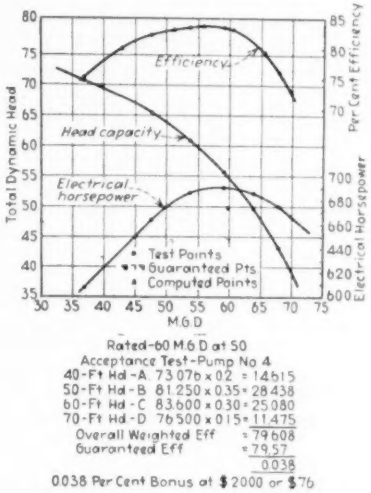
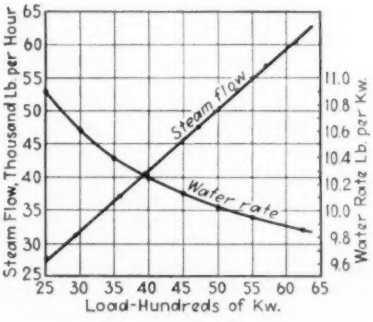


FIG. 3—OFFICIAL acceptance test curves for one 60-m.g.d. 50-ft. head low-lift pump unit (No. 4) indicated small bonus earned because of high efficiency.

FIG. 4—ACCEPTANCE TEST for 5,000-kw. turbine generator showing water rate curve under various loadings.



From a large majority of units both in the low- and high-lift pumping plants acceptances tests showed efficiencies higher than that guaranteed by the manufacturer who therefore earned a bonus. Reduced-size models of all these pumps were made up and shop-tested before the actual manufacture of the full-size units. Results of these model tests, corrected to full size, indicated that the final units should have earned a considerably greater bonus than they actually did receive from the tests of the units in their final setting. It is therefore the conclusion of the writer that the only proper location to conduct an acceptance test of any pumping unit is in its final setting for the service it is to perform.

Innumerable other items of work were necessary in placing the power and pumping plants in service, such as the final preparation and checking before the turn-over and the trial operation of the turbine generators and all auxiliaries, boilers and auxiliary equipment, coal and ash-handling equipment. In these plants there is a total of 73 recording and 851 indicating electrical and mechanical instruments, meters and gages, all of which have received special attention for correct setting and calibration. Some of the rather special meters and gages in the station are as follows:

(a) Totalizing meter system with electrically-operated indicators in several locations in the plant and office to indicate the total pumpage to the distribution system through six venturi tubes, any one or more of which may be en-

tirely out of service or carrying greatly varying flows; (b) a similar totalizing system for two large venturi tubes delivering raw water to the filtration plant; (c) flow meters for each main pumping unit where the sending element is actuated from pressure taps in the pump casing or in varying diameter pump discharge lines close to the pump. (These sending elements operate remote indicators by means of Selsyn motors); (d) electrically-operated long-distance pressure gages with indicators and recorders at different locations in the plant to show the distribution system pressure for high and intermediate services at two locations, each about 4½ mi. from the station.

These long distance pressure gages consist of a pressure coil with a torque amplifier connected to the water main. The coil makes contact to operate a reversible Warren motor which in turn positions a calibrated slide-wire resistance unit thus providing a definite mechanical position of the calibrated slide wire for any pressure condition in the water main. This apparatus is installed in a manhole at a remote point.

The slide-wire unit is connected by means of two telephone wires to a potentiometer-receiving-relay unit located in the Springwells station. In this relay unit is a similar calibrated slide wire to complete a galvanometer-potentiometer circuit. The relay unit detects minute current changes in the potentiometer circuit and amplifies the transmitted power to operate a second reversible motor which is geared to a Selsyn transmitter. This Selsyn transmitter connected through a three-wire system operates two recording and one indicating Selsyn receiving gages installed at desired locations in the plant.

Since the current is direct and the current and voltage over the telephone lines are so small there is no interference between adjacent telephone lines and the recording circuit. Because of this non-interference special filters and insulating transformer equipment, ordinarily used with long distance transmitters, have been eliminated. To secure this service over existing telephone lines for a distance of 4½ mi. for each of two gages, it was necessary to use 5½ mi. for the one and 12¾ mi. of telephone lines for the other.

Few troubles in starting

In general it was found that the plants as designed when finally put in service performed very nearly as expected. The few instances where difficulty was experienced were:

(1) Fitting of only one inclined-seat roller-type sluice gate to be utilized in any one of eight sluice-gate frames. This gate must be lowered by a building crane a distance of 100 ft. on guides and must make a watertight shutoff of any suction line connected to the low-lift pumps.

OPERATING RESULTS DURING 1935

Pumpage by the low-lift pumping plant	107.9 m.g.d.
Pumpage by the high-lift high-service pumping plant	46.5 m.g.d.
Pumpage by the high-lift intermediate-service pumping plant	61.4 m.g.d.
Head developed by the low-lift pumping plant	45.24 ft.
Head developed by the high-lift high-service pumping plant	206.03 ft.
Head developed by the high-lift intermediate-service pumping plant	130.20 ft.
Efficiency of the low-lift plant pump units	74.59 per cent
Efficiency of the high-lift high-service plant pump units	87.23 per cent
Efficiency of the high-lift intermediate-service plant pump units	84.37 per cent
Steam generated in the power plant per day	1,162,360 lb.
Coal consumed in the power plant per day	55.20 tons
Heat value of the coal used by the power plants (dry basis)	13,860 B.t.u.
Equivalent evaporation	12.63 lb.
Overall boiler-plant efficiency	89.75 per cent
Coal used per net kw.-hr. output	1.307 lb.
Plant water rate per kw.-hr. net output	13.65 lb.

During the operating period the heat rate of the power plant was gradually reduced from 18,600 in May to 17,250 in October.

(2) Fitting of only three inclined-seat roller-type sluice gates, any one of which must fit in twenty-two sluice-gate frames. These gates are operated over guides by a building crane a vertical distance of 30 ft. and must make a watertight shutoff of the suction inlet to the high-lift plant pumps.

(3) Stopping of leakage and relieving strains in several 42-in. flanged gate valves which were originally installed and bolted to rolled-steel flanges which when riveted to the ends of heavy steel pipe did not possess a truly plane surface to match the finished cast-iron flanges of the valves.

(4) Orifice plates were originally installed in the discharge lines of the high-lift plant pumps in the best location available in the plant layout to actuate the individual-pump flow meters. From the outset there was doubt whether or not satisfactory results could be obtained. Trial tests showed that they were unreliable. The orifice plates were then removed and the meters were actuated from differential pressures at selected points in the pump casings or in discharge lines at the pumps.

(5) All major equipment was installed during or earlier than 1932 and because of the inability of the Water Department to put the plants into operation before the beginning of 1935, several suppliers of equipment became quite concerned about the possible deterioration of equipment due to its remaining idle so long. The Department used every precaution with regard to the protection of bearings, glands, etc., and kept the buildings heated and ventilated as if in operation. So well was the plant taken care of that during 1934 when, at the suggestion of a steam-turbine manufacturer, turbines were opened for inspection, it was found that the interiors were in such satisfactory condition that they were closed up without taking any action other than slight cleaning of the bearings and turning of the rotor 180 deg. to allow the shop slushing compound to move in the opposite direction. Also it was thought probable that the generator end would require special drying out before being put into service; this proved unnecessary. Despite the many precautions it was found upon starting the power plant that the steam-piping system, throughout the installation period of which every known means had been used to keep the lines perfectly clean internally, had corroded to such an extent that considerable rust accumulation was carried through the lines during the first few months of operation.

Turbine tests were conducted by the forces of the Water Department in the presence of the manufacturer's representatives and were carried out in strict accord with the A.S.M.E. Test Code, except that in some instances measuring instruments were secured or made up specially to provide results even more precise than those required by the Code.

The Springwells Station operated only nine months in 1935 up to Nov. 1. During a large part of that period many meters, instruments and gages had not been checked and calibrated and work of repeated checks and calibrations were necessary and will of course be of necessity even in the future. Regardless of this the excellent operating results shown in the accompanying table were secured.

Personnel

All operating and maintenance personnel, except laborers, were secured through the Civil Service Commission of the City of Detroit. In general the Commission selected the personnel through examination, but in some instances positions were filled by transfers or promotions from other divisions of the Department of Water Supply and from other city departments.

The Springwells project was developed under the general direction of George H. Fenkell, chief engineer and general manager of the Board of Water Commissioners of Detroit. The pumping station and power plant was built under the immediate direction of William C. Rudd, assistant engineer, assisted by Frank E. Simpson on structural design; the writer in charge of mechanical and hydraulic design; C. J. Schoeninger, in charge of electrical design and construction. The consultants on hydraulic problems and pump specifications were Ayres, Lewis, Norris and May, Ann Arbor, Mich.

The Decline of Typhoid

An analytical summary of the progress and problems of typhoid control in American cities during the last quarter-century, emphasizing the influence of improved water supplies on public health

By M. N. Baker
Upper Montclair, N. J.

THIRTY YEARS AGO a typhoid death rate as low as 10 per 100,000 in an American city was exceptional. Last year not one of our 93 largest cities had a rate that high, and what is more significant, 24 communities had no deaths from typhoid. This is the best showing made since the *Journal* of the American Medical Association began publishing its annual reviews for cities of 100,000 or more population.

For readers of *Engineering News-Record* interest in this reduction centers in the part borne by improved water supplies. Before considering this and other factors in typhoid reduction a selection from the A.M.A. data will be presented. Most of the figures have been reclassified and some are put in graphical form, the better to show why progress has been so much more rapid in some than in other parts of the United States and why there is so much lag in the South generally and in certain cities of the North.

FIG. 1—HIGH AND LOW TYPHOID AREAS in the United States based on 1935 death rates in the 93 largest cities

Analysis of statistics

The A.M.A. "honor list" of 24 cities which had no typhoid deaths in 1935 and the ranking of the other 69 cities are here shown as Table 2. Only a single southern city, Jacksonville, recorded no typhoid deaths in 1935. At the other extreme are seven other cities of the South, with rates ranging from 5 to 7.6.

The yearly total decline since 1910 in the typhoid deaths of the 78 cities for which figures that far back are available is shown in Fig. 2. With minor exceptions the curve has descended each year—rapidly until 1920, then more slowly until the end of the period. The rate for 1935 was only one-twentieth of that for 1910.

Table 3 lists the cities having the highest and lowest typhoid rates in each group in 1906-10, together with the corresponding declines for 1931-35 and 1935 alone. Instead of being ranked in geographical order, as in the A.M.A. *Journal*, Table 3 is arranged by group ranking, least to greatest. This plan is also followed in Table 4, showing 1935 typhoid averages for each group but giving also group averages for other dates and also total deaths from typhoid in 1935 and 1934.

A striking difference in geographical position is shown by these tables. In Table 3, the groups are scattered helter skelter, except that the New England group has the lowest and the Middle Atlantic States the next to the lowest rank. In contrast, Table 4 shows all five of the lowest-rate groups in the North, with slightly increasing rates from the Atlantic to the Pacific. All three of the highest-rate groups are in the South, with the lowest rate also in the East, but with the second in the western and the third in the middle group as indicated by the table.

The geographical helter skelter of 1906-10 (Table 3) comes from varying conditions affecting typhoid rates, particularly the relative purity of public water supplies. Concentration in 1935 of all the low group rates in the North and all the high ones in the South indicates more rapid progress of typhoid control in the first than in the second area. This is emphasized by the averages for the two grand divisions—0.63 for the North and 3.5 for the South, or as 5½ to 1. For emphasis and clear visualization of the high-rate and low-rate areas the map (Fig. 1) is presented. It should be understood that the map shows average rates for the two grand divisions and not for the states within them; also that the 16 states not in either of these areas have no cities of 100,000 population.

Factors affecting decline

To state definitely the part that increasing purity of public water supplies has borne in the great reduction in typhoid, North and South, is impossible. Some broad generalizations will be risked, reinforced by indications for a few specific cities. In 1910, when the average typhoid rate for 78 of the 93 cities under review was about 20 per 100,000, filtration was becoming increasingly common. Chlorination had just begun. Sanitary protection of water-gathering areas was underway. Typhoid outbreaks, sending death rates to and above 100, common in earlier years,

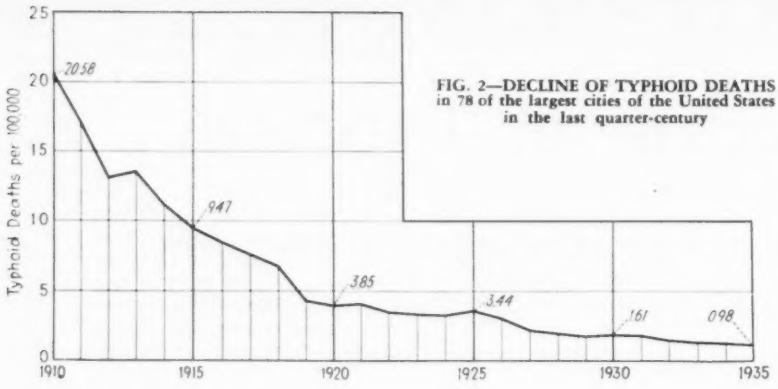


FIG. 2—DECLINE OF TYPHOID DEATHS in 78 of the largest cities of the United States in the last quarter-century

were for the most part sanitary crimes of the past. Follow-ups of typhoid cases by water and health departments were becoming general.

Although the average typhoid rate for 78 cities was 20 in 1906-10, the range of the highest rates for single years was from 74.5 to 31, and for the lowest, 35 to 9.4, the only rate below 10 per 100,000. (Camden's rate of 4 is omitted here for reasons stated in a footnote to the table.)

The topmost rate of 74.5 was in Kansas City, Kan., with data "incomplete." The rate there fell more than half in 1911-15—to 31.1. By 1931-35 the rate was 1.1. Improvements in the water supply, especially in the earlier years, must have been the main factor in this decline. These were: In 1911, larger and better filters and pretreatment facilities, replacing an old plant built in 1898; from 1913 on, chlorination.

The three cities with the lowest average rates in 1906-10 were Cambridge, St. Paul and San Diego, all northern cities located from the Atlantic to the Pacific. At that time the supply of none of these cities was either filtered or chlorinated. All were from surface sources. All were considered good for the period.

The scattered incidence of high typhoid in the eight geographical groups in 1906-10 compared with the restriction of the high rates to the South in recent years deserves further attention. The wide distribution appears to have been a concomitant of the use of polluted water supplies in many cities, coupled with poor general health administration. In the last two decades, particularly in 1931-35, there is strong reason to believe that where relatively high typhoid has prevailed it has been due to other causes than the public water supply—including, in some cases, a large percentage of the population taking its water from shallow and polluted private wells. This conclusion is supported by the considerable number of "honor-roll" cities (no typhoid deaths in a given year) that do not have filtration, although nearly all have chlorination. Moreover, nearly all the cities with high rates have filtration. This is true of all but one of the seven highest cities in the South. Of these, only El Paso does not have filters but its supply is from deep wells. Memphis now has both deep wells and filters, but the filters are for iron removal.

The excessive rates in the southern high-rate group, and the relatively high rates throughout the South must therefore be due to other causes than the public water supplies. These causes are racial, social and economic. All give rise to unsanitary conditions and the spread of typhoid from them and by contact.

The recent highly creditable decline of typhoid in the South has outrun any possible water-supply betterment in that section. It must be due to improved general sanitation and increased efficiency of state and local health departments. The need for similar improvement along both lines in a number of cities of the North, although less, is made apparent by their excess of typhoid over that of their neighbors and by common knowledge of the high character of their public water supplies.

Uncertainties in statistics

Three factors that should be given due weight in considering both the marked general decline in typhoid rates and the reliability of the rates are: (1) Uncertainties of population estimates between census years; (2) non-resident deaths; (3) deaths from paratyphoid. Although none of these can materially affect the broad general conclusions already drawn each factor creates uncertainty. All three combined give rise to still more question as to possible differences between actual and computed typhoid rates. This uncertainty may, in some cities, cause undue confidence in the control measures in force. Less important but significant still is the effect of these uncertainties upon comparisons between one city and another, particularly cities in the lower scale of rates.

Most uncertain and most important of these three factors are population estimates, particularly in abnormal years of prosperity or depression. For the latest three depression years the A.M.A.

TABLE I—PARATYPHOID AND TYPHOID DEATHS 1931-35

	Population	Year	Paratyphoid	Typhoid
Wichita.....	111,000	1935	2	0
New Haven.	163,000	1934	1	0
		1935	1	0
Oakland....	284,000	1934	2	2
Wilmington.	107,000	1932	1	1
Jacksonville	130,000	1933	1	1
Knoxville...	106,000	1935	2	6
Cleveland...	900,000	1931	1	31
New York..	6,930,000	1931	1	76
Totals.....			16	113

Journal has used U. S. Census Bureau population estimates for the year 1933. This is because the Bureau has worked up, but when the A.M.A. data were compiled, had not yet announced, a new plan for intercensal estimates of population. Acceptance of these figures as the best that can be had under the circumstances does not lessen the uncertainty as to their effect on typhoid death rates. The populations may be too high for some cities and too low for others, decreasing or raising the typhoid rates accordingly. It should be noted, however, that the old method of estimating intercensal population by arithmetic increase between the two previous census years also gave rise to uncertainties. It is to be hoped that the new plan will be better than the old.

Uncertainties in population estimates under any plan that can be devised show the need for a census oftener than once in ten years. Confined to a mere count of heads, cost of a census in 1935 would have been small. The resulting benefits would have been great to all whose planning to meet future needs and whose appraisals of results depend upon growth or decline of population.

Non-resident typhoid deaths have long been a troublesome problem. Although easy of solution for local statistics if taken in hand intelligently, it is not considered feasible to recognize them in state and national statistics. Every city of 100,000 or more has one or several hospitals and other institutions in which non-resident typhoid deaths occur. In some cities and years non-resident typhoid deaths may equal or exceed those of residents, greatly affecting the typhoid rate and rank of the city. The fewer the number of deaths in each class the greater is the effect on the typhoid rate of including or excluding non-resident deaths.

From 1929 on the A.M.A. *Journal* has given at least general recognition to non-resident deaths but only by means of foot notes to the table showing the "honor roll" and other classes of typhoid rates. In 1935 three cities reported that all typhoid deaths were of non-residents and 21 cities reported one-third or more as in that class. In 1934 ten cities reported all typhoid deaths as out-of-town cases. If non-resident typhoid had been excluded the "honor roll" of 1935 would have been raised from 24 to 27 and that of 1934 from 23 to 33. This would have made the showing for 1935 poorer than

for 1934 instead of better. Whether all cities reported the number of non-residents dying from typhoid is not stated in the A.M.A. tabulations. What the ratio of non-resident to resident typhoid was before 1929 is unknown and thus its effect on typhoid rates and upon incentives to typhoid control.

The third uncertain factor in typhoid rates is the recent exclusion of paratyphoid totals. This began in 1931 with a like change in the revised edition of the "Manual of International Causes of Death." Although this exclusion affects only 8 of 93 cities in the A.M.A. tables and lessens but slightly the yearly totals of typhoid deaths, yet for 5 of the 8 cities concerned it greatly and for a sixth it materially affects their typhoid ranking. It would do so for the other two cities if their ratio of paratyphoid to typhoid were not much lower than for the other cities. The fact that only 8 of the 93 cities are classed as having had deaths from paratyphoid in the past five years and only one as having had such deaths for even two of the five years, raise questions as to the completeness of the returns on paratyphoid. If complete, the exclusion of paratyphoid might almost be ignored except for its effect on the typhoid ranking of the eight cities for which it has been reported.

Such paratyphoid figures as the A.M.A. *Journal* gives appear in Table 1. They show that for Wichita in 1935 and New Haven in both 1935 and 1934 the exclusion of paratyphoid puts them on the honor roll. If paratyphoid had been counted as typhoid Wichita would have had a rate of nearly 2 per 100,000; the rates for Oakland and Wilmington would have been doubled and Knoxville's rate tripled.

What would have been the effect upon typhoid rates prior to 1931 if paratyphoid had been excluded? It would have made the rates more erratic, particularly in the small cities, if the A.M.A. figures for 1931-35 be taken as a criterion. It would have had less effect upon the ranking of the cities going back into the earlier years and higher rates.

Despite uncertain typhoid factors the rates have fallen amazingly for the past thirty years. But even though waterborne typhoid has been so nearly eliminated as the best evidence indicates, no available effort to carry the reduction still further should be neglected. Zealous endeavor to hold all that has been gained should be continued. Meanwhile intelligent and forceful attempts should be made to cut down remaining typhoid, whatever its origin. The many cities that now go for a year or more without a death from typhoid should be doubled in number. For those cities which cannot yet be expected to show a clean typhoid slate the standard rate for the time being should be one or less per hundred thousand population.

TABLE II—CLASSIFIED TYPHOID DEATH RATE PER 100,000 POPULATION FOR THE 93 LARGEST AMERICAN CITIES

Rearranged from *Journal American Medical Association*, June 10, 1936

Twenty-four Cities with no typhoid deaths during the year

New England	Mid. Atlantic	Southern	Mid. North	Pacific
Cambridge	Elizabeth	Jacksonville	Youngstown	Tacoma
New Bedford	Jersey City		Fort Wayne	Long Beach
Somerville	Newark		Grand Rapids	San Diego
Springfield	Paterson		Peoria	
Bridgeport	Trenton		Milwaukee	
New Haven	Erie		Wichita	
	Scranton		Omaha	

Forty-seven cities with rates up to 1.7

Detroit	0.3	Tulsa	0.7	Kansas City, Mo.	1.0
Rochester	0.3*	Albany	0.8	Lowell	1.0
St. Paul	0.3	Providence	0.8	Lynn	1.0
Chicago	0.4	San Francisco	0.8†	Utica	1.0*
Boston	0.5	Seattle	0.8†	Fort Worth	1.2
Buffalo	0.5†	Spokane	0.8	Minneapolis	1.2
New York	0.5	Canton	0.9	Cincinnati	1.3
Syracuse	0.5	Fall River	0.9	Indianapolis	1.3
Worcester	0.5	Los Angeles	0.9†	Toledo	1.3
Cleveland	0.6†	Philadelphia	0.9	Salt Lake City	1.4†
Flint	0.6	Reading	0.9	Yonkers	1.4
Hartford	0.6	South Bend	0.9	Baltimore	1.5†
Pittsburgh	0.6	Wilmington	0.9	Kansas City, Kan.	1.6
Akron	0.7†	Dayton	1.0*	Louisville	1.6
Denver	0.7	Duluth	1.0	Portland	1.6
St. Louis	0.7			Oakland	1.7†

Fifteen cities with rates from 2.0 to 4.9

Columbus	2.0†	Camden	2.5†	Dallas	2.9†
Waterbury	2.0	Oklahoma City	2.5	San Antonio	3.3†
Des Moines	2.1	Washington	2.6	Birmingham	4.0†
Houston	2.2	Richmond	2.7	Atlanta	4.6†
Chattanooga	2.4	Miami	2.8†	Evansville	4.7

Seven cities with rates from 5.0 to 7.6

Memphis	5.0†	Tampa	6.6	El Paso	7.6†
Knoxville	5.4†	Nashville	7.0†		
Norfolk	5.4	New Orleans	7.4†		

*All the typhoid deaths were reported to be of non-residents.
†One-third or more of the repored typhoid deaths are stated to be of non-residents.

TABLE III—INTRA- AND INTER-GROUP RANGE OF TYPHOID DEATH RATES FOR 1906-10 WITH SUBSEQUENT DECLINES

Groups	Number of Cities Included		Highest and Lowest Rates 1906-10	Decline in Rates 1931-35	Decline in Rates 1935
New England	13 of 14	New Haven	30.8	0.7	0.0
		Cambridge	9.8	0.9	0.0
East North Central	16 of 19	Flint	46.9	0.7	0.6
		Cleveland	15.7	1.1	0.6
West South Central	4 of 8	Houston	49.5†	3.2	2.2
		Ft. Worth	27.8	4.6	1.2
Mountain and Pacific	10 of 11	Spokane	50.3	1.4	0.8
		San Diego	10.8	1.3	0.0
South Atlantic	6 of 9	Atlanta	58.4	7.2	4.6
		Wilmington	33.0	1.5	0.9*
East South Central	4 of 6	Nashville	61.2	5.6	7.0
		Memphis	35.3	7.9	5.0
Mid. Atlantic	17 of 18	Pittsburgh	65.0	0.9	0.6
		Camden‡			
West North Central	8 of 9	Kansas City, Kan.	74.5†	1.1	1.6
		St. Paul	12.8	0.7	0.3

*Based on 1930 population.
†Incomplete data.
‡The A. M. A. figures for Camden (4.0—2.8—2.5) are omitted here because it has been learned, since this table was compiled, that non-resident deaths were excluded, a fact evidently not reported to the A. M. A. *Journal*.

TABLE IV—TYPHOID DEATH RATES BY GROUPS OF STATES FOR THE 93 LARGEST CITIES OF THE UNITED STATES

Graded by average group rates for 1935 with further averages for cities below and above 1 per 100,000.

Group	Population*	Typhoid Deaths 1935	Typhoid Deaths 1934	Typhoid Death Rates 1935	1934	1933	1931-35	1926-30	1925
1. New England	2,624,805	13	14	0.49	0.53	0.68	0.70	1.31	2.48
2. Mid. Atlantic	12,952,300	72	82	0.55	0.63	0.78	0.80	1.40	2.97
3. E. No. Cent.	9,643,100	58	88	0.60	0.91	0.55	0.75	1.29[2]	2.32[2]
4. W. No. Cent.	2,704,500	23	40	0.85	1.48	1.51	1.24	1.83	3.43
5. Mt. & Pac.	3,968,400	35	30	0.88	0.75	0.82	0.88	1.80	2.33
	31,893,105	201	254	0.63					
6. So. Atl.	2,367,307	61	50	2.58	2.11	2.31	2.70	4.50	7.01[2]
7. W. So. Cent.	1,934,800	74	105	3.82	5.43	5.40	5.36	7.32[3]	13.08[4]
8. E. So. Cent.	1,242,600	49	61	3.94	4.91	4.91	4.81	8.31	13.00
	5,544,707	184	216	3.50					

*U. S. Census estimates for 1933, based generally on annual arithmetical-increase rate from 1920 to 1930.
[1]South Bend missing for 1925-29.
[2]Jacksonville and Miami missing for 1926-30.
[3]Oklahoma City missing for 1926.
[4]Oklahoma City missing for 1925.

Filter Plant for Fort Smith Treats New Mountain Supply

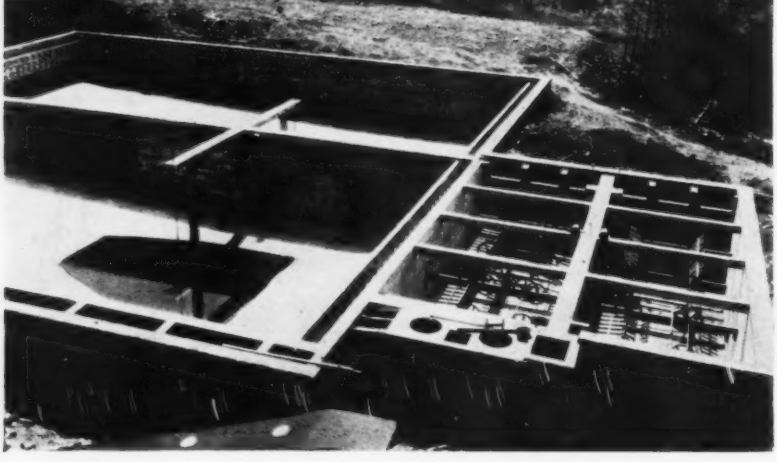
Head in flow line from reservoir generates power in plant to operate filters—Paddle mixers and controlled flow through settling basins furnish proper pretreatment—Circular clear water reservoir formed of arched wall supported by buttresses

AN UNUSUAL CIRCULAR clear-water reservoir with multiple arch walls and buttresses, perforated wall inlets and outlets to the settling basin and power derived from a turbine on the incoming raw water supply line are features of the new Fort Smith (Ark.) filter plant, located a mile below the Clear Lake mountain reservoir on the 23-mile welded steel pipe line leading to the city. Construction of the new supply project, begun in 1935, is essentially completed and the dam (see *ENR*, Feb. 13, 1936, p. 240), closed late in February, has back of it, despite the lack of rainfall, water within 20 ft. of the spillway at which level it flows into the filter plant.

The new water system is operated entirely by gravity head. Even the power for pumping the wash water for the filters and for operating all the machinery in the filter plant is generated by a water turbine unit of 10-kw. capacity. After flowing through this turbine, located in the basement of the head house, the water passes to a preliminary mixer in the basement, situated directly under the chemical machines in the control room above. In this preliminary mixer the water is mixed with lime and ammonia. It then flows to the two duplicate mixing chambers where either alum or ferric chloride is added as a coagulant. The ferric chloride will be generated by passing liquid chlorine solution through iron filings.

FILTER BUILDING and head house built of native multi-colored sandstone.

PADDLE MIXERS precede settling basins, the inlets and outlets of which have perforated flume walls.

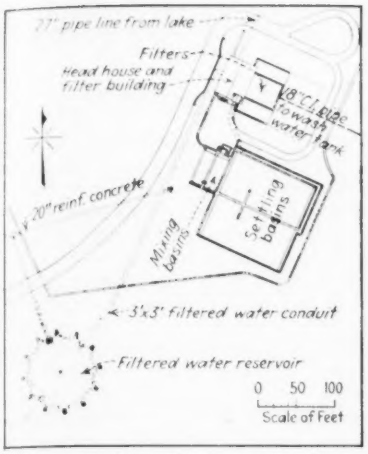


Perforated flume walls

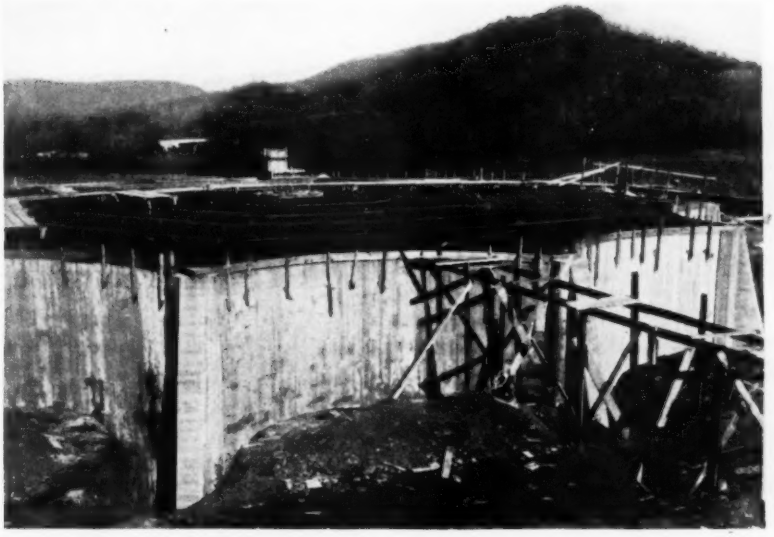
The mixing chambers provide for a 30-min. mixing period and are equipped with mechanical mixers of the paddle type operated by 4-speed motors. As the water flows out of the mixing chambers where it is treated with chlorine it divides equally into the influent flumes of the two settling basins, flows over a weir and through 8x8-in. square openings in the wall of the flume. The settling basins provide a 6-hr. settling period. Leaving the basins the water enters effluent flumes through walls perforated as in the inlet. The purpose of these openings in the influent and effluent flume walls is to provide an even distribution of flow throughout the basins. The settled water from both basins unites and flows in an open flume constructed integral with the basin wall the whole length of the basin back to a point directly opposite the head house. The water then flows underground through a 48-in. steel pipe into the head house and connects with the concrete flumes which distribute it to four 1.25-m.g.d. filter units. To prevent floc breakage the plant is so designed that after the water leaves the mixing chambers the maximum velocity never exceeds 1 ft. per second.

The filter units are of the ordinary rapid-sand type with a central gullet. The underdrain collection system is of perforated cast-iron pipe over which are superimposed 18 in. of graded gravel and 30 in. of filter sand. The wash water is stored in a covered 200,000-gal. concrete tank located on a hill 400 ft. back of the plant at a 50-ft. higher level. The wash-water tank is circular and of hoop-tension design. Two pumps are provided for pumping filter water into the wash-water tank, one directly connected on the hydraulic turbine shaft and the other driven by an independent electric motor. Ordinarily the wash water is pumped to the tank on the hill by the pump attached to the turbine.

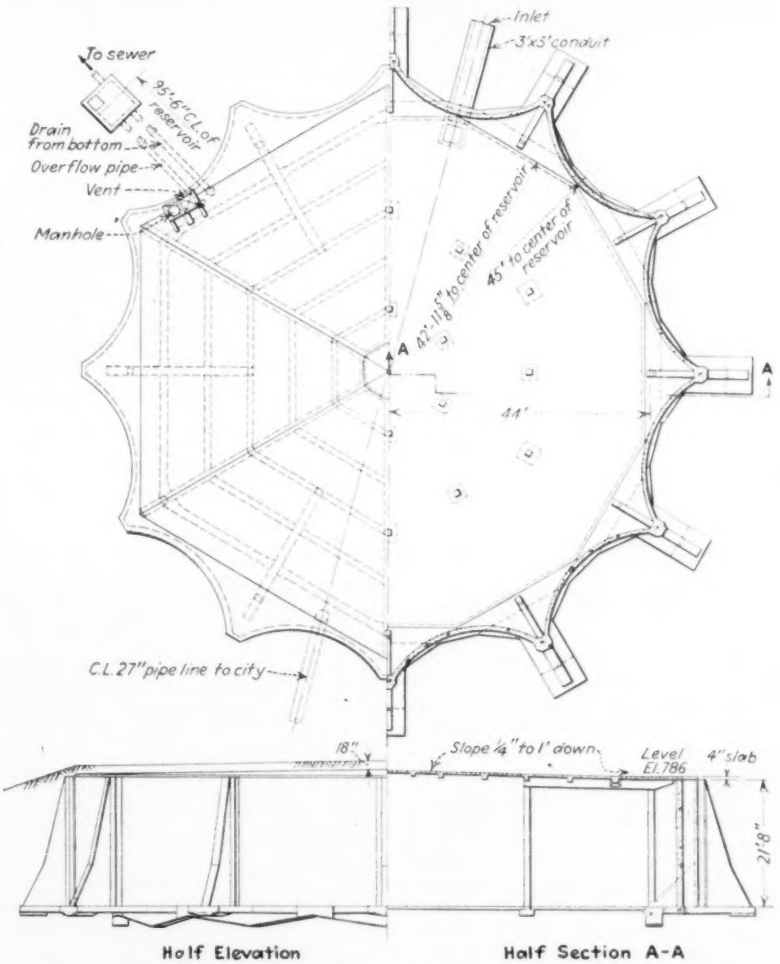
All filter valves are hydraulically operated, pressure being obtained from an automatic motor-driven pump connected to a pressure tank. The filtered water passes through rate-controllers into a reinforced concrete conduit, the top of which forms the floor of the pipe



FORT SMITH FILTER PLANT located on the pipe line from Clear Lake reservoir.



CIRCULAR CLEARWATER reservoir wall with its twelve arches and buttresses.



MULTIARCH CIRCULAR RESERVOIR of 1 m.g.d. capacity with walls all in compression.

gallery. Provision is made in this conduit, which is carried out under the floor of the head house, for final chlorination of the water as it leaves the head house. The large and roomy pipe gallery is so arranged that there is easy access to all pipes and valves.

Arch and buttress reservoir

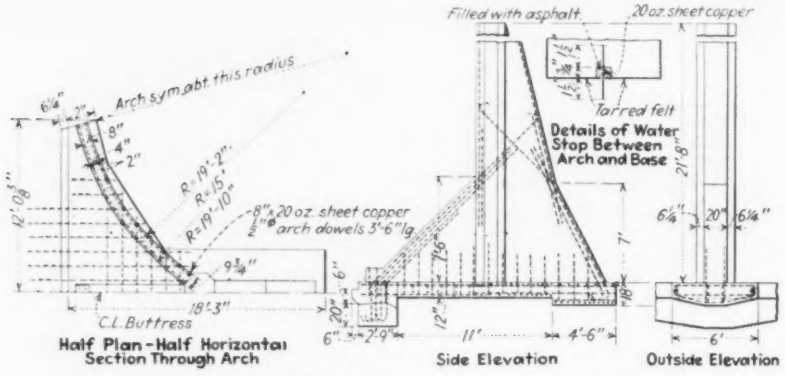
Filtered water storage is provided in a covered reinforced concrete reservoir of one 1-m.g.d. capacity, situated 300 ft. west of the filter plant building. This structure is of unusual design, inasmuch as the concrete in the walls is in compression instead of tension as in ordinary tanks with cylindrical walls. The wall consists of a series of twelve arches springing from a like number of buttresses. Details are shown in accompanying drawings. The arches are 8 in. thick and require very little reinforcement. They might have been made thinner as far as stresses are concerned, but it was felt that the thickness chosen was about the minimum to insure water tightness. A slip-joint is provided between arch and footing so as to insure full arch action.

The buttress-heel slab is part of the reservoir bottom and the weight of water superimposed on this slab adds to the stability of the walls. The design provides for the full reservoir with no outside earth pressure and for an empty reservoir with full earth pressure. The depth of the water is 20 ft. when the reservoir is full.

The beam-and-slab type roof supports an 18-in. earth covering. It is not attached to the arches or the buttresses, but merely rests on them.

In construction it was found that the buttresses and arches may be built one or more at a time as desired, using the forms several times.

Attached to the filter building and integral with it is the three-story head house. In the basement, which opens directly into the pipe gallery, is the hydraulic turbine with generator on one end and wash pump on the other, an emergency 50-hp. oil engine driving a 30-kw. generator, the automatic pressure set and tank, motor-driven wash pump, three-panel switchboard, toilet and shower. A 24-in. venturi meter


Filled with asphalt
20 oz. sheet copper
Arch sym. abt this radius
Tarred felt
Details of Water Stop Between Arch and Base
8" @ 20 oz. sheet copper
1/2" ø arch dowels 3'-6" lg
C.L. Buttress
Half Plan - Half Horizontal Section Through Arch
Side Elevation
Outside Elevation

ARCH AND BUTTRESS design details of the filtered water reservoir.

tube on the raw water line is suspended from the ceiling of the basement. A 24-in. motor-operated gate valve furnishes control of the incoming water. In winter the filter building and head house is heated by an oil-burning steam boiler also located in the basement. The heat is distributed by two unit heaters, one blowing heated air into the pipe gallery where it will pass up through the openings under the operating tables into the filter room. The other unit heater blows the hot air through an open well into the main lobby of the head house. Steam radiators are provided in the laboratory and in the chemical control room.

The second floor of the head house is on a level with the operating floor of the filters. On this floor is located a complete chemical and bacteriological laboratory. Across the entrance hall is the chemical control room, in which are three dry-feed chemical machines, two ammoniators, two liquid chlorine machines and the control mechanism for the ferric-chloride generating plant. The venturi meter register and the push button for operating the motor-operated raw water valve are also in this room, so that the operator may change the rate of flow of the plant to any desired amount, which will be indicated by the meter register in this same room, and then may adjust all chemical-feed equipment to take care of the changed rate of flow, all without leaving this room. This plant was designed from the operator's standpoint, to minimize effort to centralize points of control and observation.

Liquid chlorine is to be stored outside of the building in 1-ton containers, five of them connected to a header system just outside of the chemical-control room. All other chemicals are stored in the third story of the head house on movable wooden platforms. A 2½-ton lift truck is provided to move these platforms with their load of chemicals. A motor-operated elevator, also of 2½-ton capacity, is provided to take the chemicals from the unloading platform to the chemical-storage room.

Architectural features

Due to its setting in the timbered mountains the building was designed in the modified Norman type of architecture, its material being the native sandstone, which in this locality presents a variety of color and shade in browns and grays. The roof is of red tile. The elevator shaft and the flue for the furnace are designed as an ornamental penthouse on the head house of the filter building. Two operators' residences are of the same type of stonework, and tile roof, built on the hillside back of the plant among the trees. The settling basins and the mixing chambers are connected to the filter building by a stone wall matching the building and a similar sandstone facing and coping was placed on the exposed walls of the settling and mixing basins. The architect for the exterior of the building was John Duncan Forcyth of Tulsa.

The total cost of the filter plant and appurtenant structures, including the operators' residences, was $175,000. The contractor was M. E. Gillioz, of Monett, Mo., W. R. Grimshaw and Co., Tulsa, being the subcontractor. W. R. Holway, consulting engineer, Tulsa, prepared the plans and supervisesd construction. Victor H. Cochrane was associated with him in part on design of structures. W. T. Barry, Fort Smith, was the resident engineer. The whole $1,700,000 project was financed with the aid of a PWA loan and grant. C. S. Young was resident PWA engineer inspector.

Service Data on Creosoted Pine Poles Available in Report

PRESSURE TREATMENT of southern pine poles with creosote until three years ago was done under a *process* specification rather than a *result* specification. New specifications based on results were adopted in 1934. R. H. Colley, chairman of a committee on the subject, presented at the Memphis meeting of the American Wood Preservers Association last January, voluminous data prepared by the Bell Telephone Laboratories based on service tests and inspections which backed up the soundness of the new specification. These provide that the penetration in any pole shall not be less than 2½ in. unless 85 per cent of the sapwood is penetrated, and the net retention shall not be less than 8 lb. of creosote per cubic foot of wood. The new specification provides also for a 10-lb. retention with a penetration not less than 3 in. unless 90 per cent of the sapwood is penetrated, and a 12-lb. retention in which the penetration shall not be less than 3½ in. unless 90 per cent of the sapwood is penetrated.

The present report of the committee on creosoted pine poles is of special interest not only to the wood-preserving industry but to all consumers of wood poles because of the comprehensive data which it makes available on service records, which data have been collected, analyzed and interpreted over a period of years at great cost by engineers associated with the Bell Telephone Laboratories.

The data submitted, based on a large number of creosoted pine poles from Florida to Wisconsin and from the Mississippi River to the Atlantic Coast, and now available through this report, make it possible for the first time to predict with confidence and accuracy the minimum service life that may be expected from creosoted pine poles when treated under the standard specifications of the American Wood Preservers Association. The committee report emphasizes particularly the fact that decay is correlated only with the depth of radial penetration measured in inches and percentage of sapwood treated and is not definitely correlated with species of pine poles, with the type of creosote used or with the climatic conditions encountered. Poles having creosote penetration of 2½ in. and 85 per cent of the sapwood thickness are practically immune from serious internal infection for many years, and in this group of poles, inspected over a vast area, there were none that failed in lines up to 26 years in service.

Long-Delayed Filtration Plant Completed at Fort Scott, Kansas

Water supply improvement first advocated in 1915 is added to half-century old system with aid of PWA funds

By Freeman D. Martin
Commissioner of Streets and Public Utilities, Fort Scott, Kansas

IN JANUARY OF THIS YEAR the city of Fort Scott, Kans., with the aid of PWA funds, completed a water filtration project that had been advocated for more than 20 years. Construction of the 4 m.g.d. rapid sand filter and a booster station combined with an elevated tank to improve pressure distribution brings to the 10,895 inhabitants of this city a modern water supply system that was first started in 1882 by a private company.

Fort Scott receives its water from the Marmaton River, having two dams between the main pumping station and Rock Creek Lake where a reserve supply of 233 m.g. is impounded. Although the water is of good quality, the added assurance of filtration was felt desirable as far back as 1915, when bonds were voted for the construction of a plant. No action was taken, however, and despite continued efforts to revive the issue nothing more was done. In 1933 the writer was elected to office on a platform guaranteeing better water and better service, and aided by a $145,000 PWA loan and grant the improvement project was started in 1935 with designs and plans prepared by Black and Veatch, consulting engineers.

The new plant, whose capacity is double the normal requirement, consists of an air agitated mixing chamber, chemical building, settling basin and a filter building. The chemical building, 63½ ft. x 29½ ft., provides ample storage for two carloads each of lime and alum and in addition houses the equipment for applying chlorine, ammonia, activated carbon, alum and lime. The chemical mixing, coagulating, settling and clear well basins are of the following sizes: 86 x 129 ft., 85 x 129 ft., 100 x 130 ft., and 97 x 129 ft. respectively; all basins have a depth of 14 ft. They are designed to treat water at the rate of 3.25 m.g.d. and provide a detention period of 40 min. for mixing, 14 hr. for coagulation and settling, followed by 40 min. in a secondary mixing basin chamber and then 9 hr. detention for settling.

The west side of this basin has been fitted with a collecting weir and flume which leads direct to the influent lines of the filters. All basins have distributing and collecting flumes and are equipped for bypassing to make basin cleaning possible. All basins can be used in series if so desired.

The filter building, 62 x 68 ft. in plan and 36 ft. in height, houses the four 1 m.g.d. rapid sand filter units (each 20 x 18 x 11 ft.) and a completely equipped laboratory for water analyses. The filter design provides for 18 in. of gravel overlaid by 22 in. of graded Kaw River sand.

Distribution of the filtered water is made through a system comprised of 45 miles of cast iron pipe ranging in size from 4 to 16 in. A low pressure area in one portion of the city has been corrected by the installation of an automatic, electrically controlled booster station and a 200,000 gal. elevated storage tank. The pumping station, which is automatically controlled, includes two 250 g.p.m. centrifugal horizontal pumps driven by 15 hp. motors. These pumps can be used separately or in series.

The location of the pumping station and tank necessitated the laying of 3,200 ft. of 10-in. and 5,000 ft. of 8-in. cast iron pipe in addition to 1,700 ft. of ¾-in. copper tubing used for water level control in the elevated tank.

FIG. 1—OPERATING FLOOR of the 4 m.g.d. filter plant at Fort Scott, Kansas.

FIG. 2—LOW PRESSURES in one portion of the water systems were corrected by adding this 200,000 gal. elevated tank.

Chlorine for Algae Control at River Rouge Power Plant

CHLORINATION of all mill water used in the Ford Rouge plant, to provide additional safeguards against infection to workmen and to end the growth of algae in pipe lines is a feature of a new pumping station costing more than $300,000. The new station houses three pumps, each with a capacity of 37,500 gal. per min., at 85 lb. discharge pressure. The supply of water will be obtained from the 15-ft. tunnel from the River Rouge that now serves the plant.

Periodical applications of chlorine to river water used in condensers of the feed turbine electric generators in the Rouge power plant have been found to eliminate the trouble caused by algae slime in the connector tubes.

For the treatment of mill water alone, aside from condenser requirements, from two to three tons of chlorine a day will be used, as compared with about 150 lb. a day for the city of Detroit's water supply.

MOSQUITO CONTROL ENGINEERING VIII

Malaria and the Mississippi Valley

In the "malaria belt" of the United States the toll of mosquitoes is 10,000 deaths per year — Although medical science has no economical means for curbing the spread of this disease the engineer can build it out of communities by simple means

By J. A. LePrince
Senior Sanitary Engineer
U. S. Public Health Service

DURING THE PAST YEAR it is estimated that there were about 10,000 deaths caused by malaria fever in the so-called "malaria belt" of our country, an area extending south of a line between Norfolk, Va., and St. Louis, Mo., and concentrated in the region of the Mississippi River. Furthermore, in addition to the dreadful mortality there were about 500 "recovered cases" of malaria to every death—each one of these cases required the expenditure, on an average, of $17.30 for medical service and drugs. (*Economic Losses from Malaria*, by A. W. Fuchs, p. 4.) This alone represents an alarming economic loss without counting the further financial losses due to non-productive activity by fever-ridden individuals. With these facts at hand there can be no denying that malarial mosquito control, a problem that may be solved by engineering methods, is one of greatest importance to the welfare of a large proportion of our nation.

Status of present activity

In the southern states, with the exception of anti-malaria work on lakes being done by hydro-electric companies, nearly all of the mosquito abatement activities have been inaugurated through efforts of state health departments. Many of the counties have full-time health departments, and the state health departments help the county officers to get work started in thickly settled rural communities, villages, and towns where the authorities are favorably inclined and feel able to finance such activities. The state health department generally contributes supervisory engineering assistance, and the work in the past, largely confined to towns and suburbs of cities, has consisted of drainage and its maintenance and treating water with oil or other larvicides. Since the beginning of the depression period, with labor paid from federal funds, anti-malaria drainage has been largely increased.

In a few instances in rural districts the county health departments have undertaken county-wide screening campaigns with a view to having as many as possible of the farm tenant homes protected and made mosquito-proof. This work, organized by the county health department and paid for by the property owner, has averaged less than $10 per farm tenant home.

Malaria in the Mississippi Valley presents a number of problems. Most of the people in this region do not realize its relative economic importance, and that is one reason why more precautionary activity is not undertaken. To develop adequate interest much educational work yet remains to be done, but it will have to be carried on systematically in the school systems over a period of years to bring about desired results. That such interest can be aroused was clearly demonstrated at Memphis, Tenn., by high school students who voluntarily made to scale large models of disease bearing mosquitoes that were carried in a parade viewed by sixty thousand people. Methods of developing interest of the public in health matters of this kind are being carefully studied and worked out in the T.V.A. area at the present time.

At the county seats in the farming area a large portion of the farming population spend Saturday evenings up to and after dusk in the shopping district and in the courthouse square, and such localities are as a rule excellent foci for the spread of malaria. If the chambers of commerce, the county engineer, and the merchants were more interested in the problem, plans could and would be made to drain or permanently treat nearby breeding places of *Anopheles* so they would no longer exist. This would enable the local business interests to sell more goods because of a larger earning power of the rural labor and farming population.

At the present time it is not unusual to find many permanent sources of anopheline mosquitoes close to where the human malaria carriers congregate.

Proper drainage essential

The problems of malaria reduction in town suburbs and in farming districts are distinctly different. In the former case it is possible in most instances to line the bottoms of ditches with a shell of concrete, or stone and mortar, and thus so increase the rate of water flow during the malaria season that propagation of *Anopheles* ceases. This method was employed in Panama when work was begun in 1904. For reasons not altogether understood by the writer it was not looked upon favorably at one time by the chief engineer. But later, when the maintenance cost and oiling cost of open ditches was compared with interest cost of lined ditches, the engineers then in charge reverted to the practice of lining ditches at the permanent villages and thus reduced total annual expense by returning to the original plan approved by General Gorgas.

It is in every way as important to line with concrete the bottom of suburban ditches in the malaria belt as it is to construct concrete sidewalks in towns. Unfortunately this important point appears to be ignored in the instruction given to engineering students in many of our state universities. Another point apparently lost sight of is that where sewers are discharged into stream beds of low flow the quantity of pestiferous mosquitoes produced in such water is frequently increased a hundredfold or more, and often causes home owners to go to the heavy expense of screening their porches, which would not otherwise be necessary. These pestiferous mosquitoes (*Culex quinquefasciatus* in the southland and *Culex pipiens* further north) multiply much more profusely when water is contaminated by sewage. In some suburbs because these sanitary aspects of drainage are ignored by engineers and town commissioners the annual cost of screening of balconies may be much greater than the cost of sewer extension.

In towns close to rivers, or where the lands near the suburbs are subject to river inundation, the seasonal malaria prevalence may be dependent on the flood season. If the overflow occurs when the temperatures reach 76 deg. F., and if the water remains high for a period of twelve days or more, the quantity of malaria mosquitoes will increase tremendously. Last spring at Vicksburg, Miss., the writer was bitten on an average of more than once per minute while waiting for an early morning train at the railroad depot.

Under such conditions the chances for malaria transmission are excellent.

In the rural districts where the main crop is cotton, we have the problem of a frequently changing farm tenant population. The tenant gambles on getting a bigger return by living in the lowlands, frequently on or near the river overflow territory. Eventually he or members of his family contract malaria. Thus they become malaria carriers and their illness and inability to make "both ends meet" forces them to move back to the hill country where they help to infect their neighbors via the *Anopheles*. It is a vicious circle that cuts profits of both tenant and landowner.

Another important problem is that of ditch maintenance, because as the hill country is cleared a quicker runoff results and the ditches must carry larger loads. The ditch bottoms become clogged and soon vegetation grows which protects the larvæ of the mosquito from its natural fish enemies. It is therefore essential that engineers devise schemes for making ditch maintenance less expensive—of practically changing the clay bottom drains into the equivalent of hardpan so that there is less vegetation and less collapsing of side banks.

The malaria mosquito breeds in residual water that remains after storm water has passed. Consequently, if wide-bottom concrete-lined ditches are built without constructing a central rounded inner channel in the bottom an ideal condition for the propagation of these mosquitoes will be maintained.

The problem in review

The financial status of any town is dependent on the economic wealth of surrounding territory and where this territory is highly malarious commercial interests are vitally affected. Because of a shortage of funds, however, town commissioners are slow to adopt measures to permanently build malaria out of their community. And the sad part of it all is that in the states to the north of the present malaria belt many water courses were concrete lined when federal funds were recently available for such work, but the engineers in the malaria belt were not ready and did not grasp the opportunity while it was present. As a result, many useful citizens have been sent to the cemetery who should be enjoying life at the present time.

It is said by veteran malaria control engineers that in their work the thing they must expect is "the unexpected." Apparently they will not be surprised when in the near future the present river valley malaria belt extends up into the hill country. There are strong indications that this soon may happen, and there is every reason to believe that it may also extend northward to those states where it was eradicated all of thirty years ago.

Beyond a doubt it is essential that we conserve our soil resources, that we re-establish our forests, and prevent rapid runoff and river floods. Activity in this direction has already been under way for some time and we have built small dams in many stream beds and shall build many thousands more. And though we may not have heard it, Madam *Anopheles* has already said, "Thank you" and is re-establishing her race rapidly where topographical conditions made this impossible in the past. What will happen? Personally, I believe it is high time that the American engineer should wake up and get busy. The medical profession fully realizes that up to date we have no economical medical means of controlling malaria on a wholesale scale.

Granted that we have reached a point where we must put a stop to permitting the richest part of our lands from being transported to the Gulf of Mexico, toward which end are constructed thousands of ponds and small lakes in the hill country. But in the past year or two our malaria sick rate has doubled. Apparently it is time to stop laughing at mosquito control as a joke. Ten thousand or more deaths per year may be a joke to the mosquitoes that convey disease but not to the two million Americans who will want to know why, if control is a simple engineering problem, the engineering profession continues to ignore it.

California's Campaign

With an organization comprising 24 mosquito abatement districts, California has carried on an aggressive program of eradication for more than two decades

By Harold F. Gray
Engineer, Alameda County Mosquito Abatement District, Oakland, Calif.

FOR MORE than two decades California has been waging state-wide warfare against mosquitoes through the agency of 24 abatement districts, thirteen of which are concerned primarily with the elimination of malaria vectors, nine with salt-marsh pest mosquitoes, one with fresh water varieties and one with the hippelates fly. Eradication measures were first begun in 1909, with a program financed by private subscription in a suburban real estate development near San Mateo, followed one year later by the inauguration, in Placer County, of the first anti-mosquito malaria control campaign in the United States; shortly after this, malaria control work was extended to an irrigation project. The success of these campaigns, and public demand for their continuance and extension resulted in the passage of the Mosquito Abatement Districts Act in 1915 under which the present work has been developed.

Mosquito abatement work in California is characterized by wide variation in geographic and cultural conditions, as well as climatic variations. Topographically, the state consists of a great central valley, lying between the Coast Range on the west and the Sierra Nevadas on the east. Isothermal lines run generally north and south, so that there is litlte variation in mean temperatures, other than those resulting from altitude. Rainfall precipitation varies greatly, however, ranging from an annual mean of about 109 in. in Del Norte County to about 1½ in. in Death Valley.

In the great Central Valley, (a fairly flat alluvial plain traversed by the Sacramento River and its tributaries in the north, and the San Joaquin River and its tributaries in the south), *Anopheles maculipennis* — the principal malaria vector in the state—was formerly very abundant, extending its range up into the Sierra Navada foothills to an elevation of 2,000 ft. or more. Malaria, which was unknown in the Spanish settlements along the coast, was introduced into the valley some time (probably) prior to the gold rush of 1848-51. Malignant or tropical tertian fever was probably introduced in quantity via Panama during the gold rush days and was a scourge of the gold camps under the name of "miner's fever." It remained prevalent in the valley and its foothills throughout the later agricultural development of the state, with local increases in intensity upon the advent of irrigation.

Malaria in California has been markedly reduced since 1910. The death rate per 100,000 of population dropped from

PROLIFIC MOSQUITO BREEDING occurred on this marsh where drainage was restricted by improper culvert installations in the railroad embankment (right).

4.9 in 1909 to 0.05 in 1933. The reported case rate has shown a roughly parallel reduction. Not all of this reduction can be attributed to the work of the mosquito abatement districts, as a few county health departments have done excellent malaria control work, and an effective educational campaign has contributed to the result.

Location of species

In the San Francisco Bay area very effective abatement work against the migratory salt marsh species has been carried on. The relief from pest mosquitoes has materially aided in the development of the entire Bay area, helping the real estate business and the dairying industry especially. The salt marsh mosquito nuisance also occurs on the southern coasts of the state, near Los Angeles, and on San Diego Bay, but control work there is less well organized.

In the San Francisco and San Joaquin valleys two types of pest mosquitoes are prevalent, as well as the malaria-carrying anophelines. These are typically flood water mosquitoes, *Aedes dorsalis*, breeding in overflow areas and in the vicinity of the rice fields, and *Aedes vexans*, restricted in breeding area to the brush-covered river bottoms. Both are migratory over a considerable range.

In the high Sierra Nevadas several species of *Aedes*, especially *A. communis tahoensis*, *A. hexodontus* and *A. ventrovittus*, are the bane of vacationists and mountain climbers. In Yosemite National Park considerable success has attended the control work of the Park Service; in fact on the floor of Yosemite Valley *A. increpitus* has been practically exterminated. The National Park Service depends entirely on oiling for control work, neglecting the more effective and more permanent methods of drainage and filling. They also use the black, unsightly heavy oils, instead of the lighter and more efficient distillates.

The ever present domestic mosquito, *Culex pipiens*, breeds continuously throughout the year under urban conditions in practically all parts of California. In many parts of the state field types, such as *C. tarsalis*, also breed practically continuously, though the rate of production is of course much less in winter. As a result, while work against fresh water species can be diminished in the winter, it cannot be entirely suspended, and abatement work is therefore practically a twelve months program. In central California for example, the larvæ of *Aedes squamiger* begin to hatch about the first week in January, emerge about the second week in March, and migrate from the third week in March to about the middle of April. Their flight range has been observed at from 40 to nearly 60 miles. The species is single brooded around San Francisco Bay, but it has at least two broods per year on San Diego Bay. *Aedes dorsalis* and *Aedes taeniorrhyncus*, our other salt marsh breeders are multi-brooded, from March or April to October.

In the central valley, *Anopheles maculipennis* goes on a marked dispersal flight of several miles about February 20th each year. The production of anopheles gradually increases through the summer until maximum output occurs in August, with a maximum incidence of malaria (under uncontrolled conditions) usually in September.

Control methods and problems

Climatic conditions are favorable to the use of fish as a control medium, and *Gambusia affinis* has been propagated and planted in many parts of the state with excellent results. It has been adapted to brackish water as well as fresh water.

Petroleum distillates have been relatively cheap (4½c. to 5c. per gallon delivered) and highly toxic, and under California conditions they have proved more economical and effective than either cresylic acid or pyrethrum larvicides, which cost from 35c. to 55c. per gallon locally. We have been unable to duplicate the results obtained in New Jersey with pyrethrum extract larvicides, and these have so far failed to prove either economical or efficient in our work. Paris green has not been used to any great extent against anopheline larvæ, although there are many situations where its use would appear to possess advantages over oil.

In large parts of the state natural conditions are not particularly favorable to mosquito production, due to the long rainless summers. However, man's carelessness with his structures provides numerous breeding opportunities which keep the abatement official very busy. Carelessness with water on irrigated districts, and especially in the rice fields, has been common, though public education and the increasing value of water has reduced this difficulty in recent years. We still have a great deal of trouble with engineering works. The railroads, the state highway and the county highway departments are constantly and needlessly creating new breeding places. While the railroads have cooperated in correcting faulty drainage when asked to do so, the state highway appears to be rather unconcerned with mere human comfort or the public health.

Underground structures

Various public utilities with their underground structures in the streets have created numerous excellent breeding places in cities but generally they have been most cooperative in doing their part to minimize this condition. But we still have thousands of storm water inlets on the sewer system, which are prolific mosquito breeders, and it is a tremendous task to combat the propagation that takes place in these basins.

And finally, how about the genus *Homo* in California? The best answer I can give is that in this state he is no more and no less careless than in other parts of these United States. At times, however, it seems as if he can make more useless and unnecessary mosquito breeding places than any conceivable abatement agency can cope with. But conditions do improve, and our intensive educational propaganda produces noticeable benefits in this respect.

Straightening a Leaning Building

Inclined shores resting on jacks and pushing at the several floor levels prove successful—Three badly bent columns reinforced in their out-of-plumb position

A SUCCESSFUL JOB of righting a leaning four-story building which had been thrown out of plumb some 16 in. at the top by an explosion in an adjacent building was completed in Chicago early this year. The building, about 70 ft. long north and south, and 35 ft. wide east and west, a part of the soya products plant of the Glidden Co., is of steel frame construction with concrete floors. Its west wall was the east wall of the building in which the explosion occurred. By utilizing inclined shores, bearing against the several floors, the columns were restored to plumb, with the exception of three badly bent columns which had to be reinforced and remain in their out-of-plumb position. The building had only recently been completed so that the restoration saved a considerable investment.

The explosion occurred in a building 100 x 150 ft. in plan, and about 70 ft. high, which had been remodeled to house a new extraction process. This building was completely destroyed, and the force of the explosion moved the adjacent building 16¼ in. east and 5 in. north at the top. The explosion drove steel girder beams entirely through the brick party wall between the two buildings. The bases of all the steel columns in the new building remained at their original position, the columns in most cases being merely moved out of plumb by pivoting about the base. However, three columns in the south wall bent at a height of 4½ ft. above the base, the depth to which they were embedded in concrete and brick.

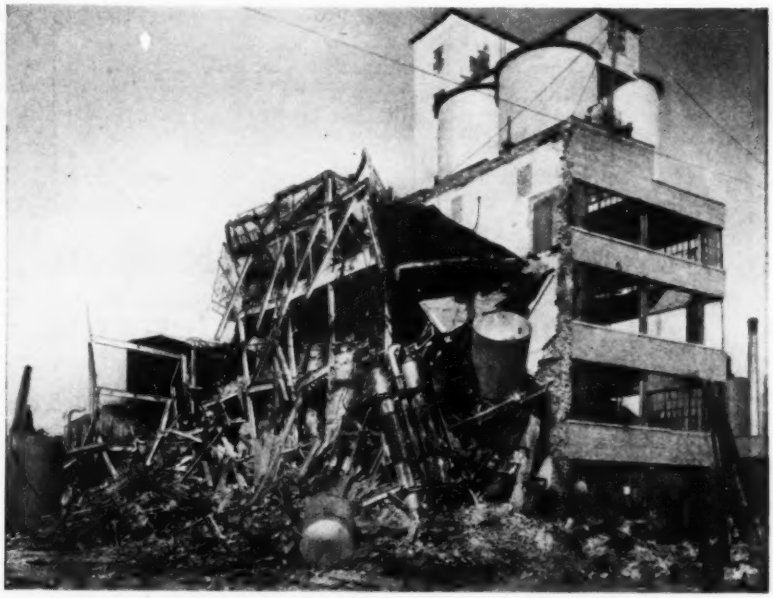
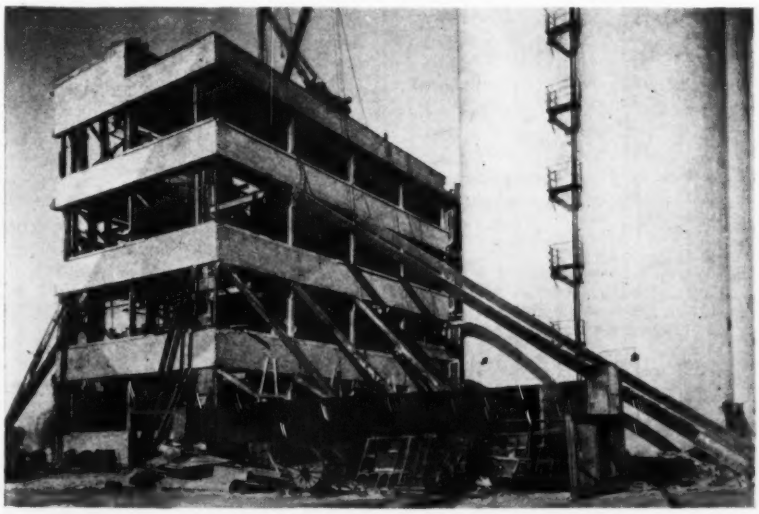


FIG. 2—REMOVING THE WRECKAGE that was piled against the west wall of the new building by the explosion

The explosion left the new building and the extraction equipment in the east end of the old building in a very hazardous condition. Temporary shoring was immediately placed on the side of the building opposite the débris which was removed as soon as possible with power shovels, graders and trucks. With this weight removed, the straightening and stiffening operations could begin.

Inclined shores were placed entirely around the building. As shown in Fig. 1, these consisted of 16x16-in. timbers

FIG. 1—INSTALLING long timber shores against east wall. Jacks at the base of these shores and of the steel drums were used to force the building back to plumb



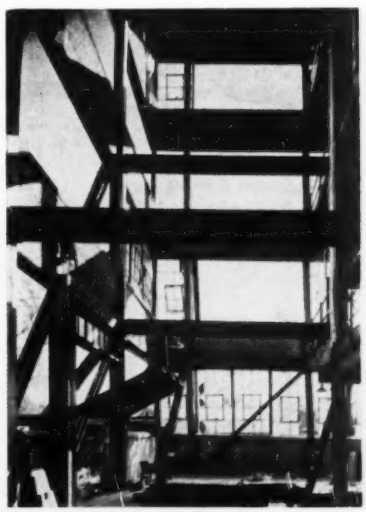


FIG. 3—BENT COLUMNS in the south wall (background) which were reinforced without straightening after their upper stories were brought back to plumb, pivoting about second floor

72 ft. long, for the upper stories and steel extension drums for the lower stories. All shores were equipped with jacks at the lower ends.

As pressure was applied with the jacks on the north and east sides of the building, those on the west and south were released an equal amount. To prevent distortion, jack movements were made in proportion to displacement at that particular point, so that all parts of the structure reached their original position practically at the same time. Large wing brackets were then attached to the columns and to the bottom of the beams on the interior and the east row of columns. Not considering the south columns in the first story, all points on columns at every floor were returned exactly to plumb with two exceptions where at intermediate points readings showed 1/16 in. variation.

No attempt was made to straighten the three columns in the south wall which were bent in the first story. When these columns had been moved back toward their original position until the column center at the second floor reached the plumb line over the base, they were fixed at this point by bracing shores. Then with this second floor elevation as a center, the upper stories continued to move toward the original position, while the first story columns were free to move to as natural a position as they would assume. Diagonal rods were installed to assist in bracing this south row of columns. Cover plates were also placed on the columns throughout the first story, to compensate for the loss in strength due to bending.

N. Ronneberg, Inc., were the engineers and E. I. Leander the general contractor, under whose order Gooder-Henrichsen Co., Inc., with Gustav Hansen in charge, restored the structure after the explosion.

Double-Track Bascule Span Employs Welded Design

Saving of 20 per cent in counterweight tonnage gave welded design for a 54 ft. span an advantage over riveting—Erected under traffic with aid of rivet bolts

By Heath Lawson
Field Engineer
Bethlehem Steel Company, Bethlehem, Pa.

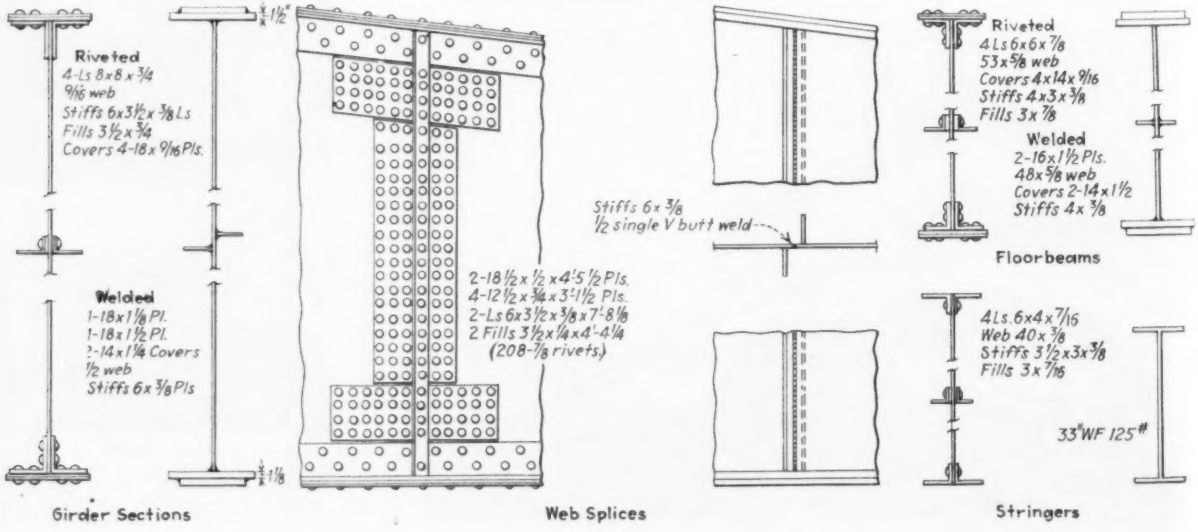
FIELD WELDING was adopted and carried out successfully in constructing the new bascule span in the Florida East Coast Railway line at Jupiter, Fla. This all-welded structure replaces a 54-ft., single-leaf, double-track, through bascule span that was wrecked early in 1935 by a train running into a partially opened draw. In the same accident the north end of the south approach span was damaged. The conventional single-track, deck-plate girders of this span were straightened and repaired by welding, and the west pair of girders moved into the east track on pile bents to provide temporary single-track service.

Designs were prepared for an all-welded span to replace the riveted draw, merely by substituting modern welded members and details for the riveted members of the old design. Fig. 1 shows comparisons between the riveted and welded girders, floorbeams and stringers. The riveted web splices illustrated required half a ton more material than in the welded design which also permitted similar economy of material for the pin plates in the girders. The welded span weighs about 20 per cent less than the riveted structure which is translated into savings in operating power.

Bids were asked on the two designs, based on furnishing and erecting the structural steel, reconditioning the operating machinery, and filling the counterweight boxes with concrete, punching and steel rails. The rails were to be furnished by the railroad. The bids favored the riveted design, but the extra cost of furnishing 20 per cent more rails influenced the company to decide upon the welded design. The structural steel for the welded span weighed 110 tons. Two 70-ft. girders, the longest pieces in the structure, weighed 27 tons each. The counterweight filling of 196 tons includes 115 tons of old rail steel.

The bridge was fabricated in the Pittsburgh district and transported to the erection site by rail. Before shipment the span was completely assembled and erection holes reamed and matched. All important connections were made

FIG. 1—COMPARISON between welded and riveted members for a 54-ft. span railroad bascule.



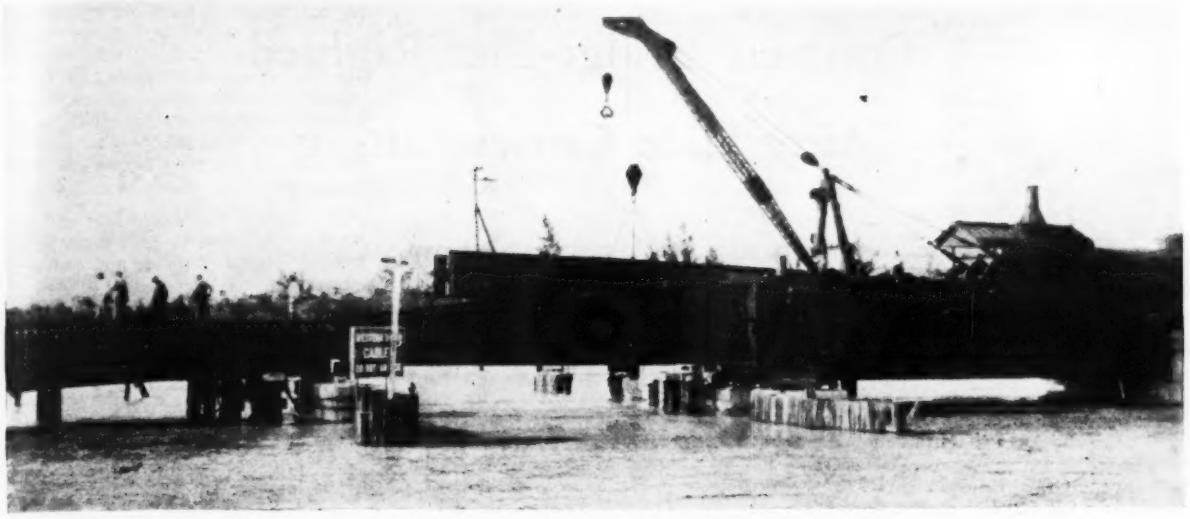


FIG. 2—WELDED bascule complete, the locomotive crane removes the temporary fixed span which carried trains during the construction period.

with Dardelet rivet bolts inasmuch as the bridge was to be erected under traffic and to be capable of carrying full train loads at reduced speed immediately after setting.

All joints, shop and field, were 100 per cent welded. The bolts used during erection were assumed to be inactive when the welds were completed. Bolts located in inconspicuous places were not removed. Those that would mar the smooth, finished appearance usually associated with welded structures were, however, taken out, and the holes filled with weld metal.

All field welds were made with $\frac{5}{32}$-in. covered electrode, using a single pass, triangular weave, similar to that employed in bare wire welding. The field welds, exclusive of seal welds, were mainly $\frac{3}{8}$-in. vertical, except for the lateral bracing, where $\frac{1}{4}$-in. flat welds predominated. The weld size, location and procedure were planned to reduce distortion. No peening or stress relieving was resorted to.

The span was erected in the closed position and in accordance with a procedure based upon using the interrupted west track as a side track while clearing for trains, and erecting from both tracks between trains. There were three clear periods each day, a $1\frac{1}{2}$ and $2\frac{1}{2}$ hr. period in the morning and a 3-hr. period in the afternoon.

Both trunnion towers and main girders were erected without disturbing the temporary girder span. Meanwhile two panels of stringers and bracing were assembled and welded to the two interior floor beams, to form two erection units. The bracing was completely welded in place.

In making the change-over on a Sunday afternoon, the temporary girder span was picked up and loaded on a flat car. Then the first floorbeam was set, followed by two panels of steel. The third panel was set piecemeal since clearances did not permit its erection as a unit. While this work was progressing, ties and rails were being laid; bolts were being placed and the bracing of the third panel was being welded. On the span, the derrick car, assisted by a railroad crane, placed the new approach span in the west track. While the total elapsed time between trains was but $6\frac{1}{2}$ hr. the actual replacement of the draw span was accomplished in $2\frac{1}{2}$ hr.

After the changeover, single-track operation continued over the west track, thereby permitting further repairs to be made on the south approach span of the east track. The time consumed in filling the counterweight boxes permitted a single welder to complete the field welding of the span.

Welding under traffic presented no difficulties, although care was taken not to start a weld that could be overloaded by the next train. For example, a short weld on a floor-beam connection might tend to carry more than its share of the load and cause the weld to crack when a train passed over the bridge.

For every ton of structural steel involved there was 70 ft. of welding, of which $5\frac{1}{2}$ ft. was field welding. A comparison between welding and riveting costs is difficult in this case because the contract specified all seams to be seal-welded which is not done on a riveted job. This sealing work constituted a large proportion of the total welding done.

Thomas A. Gardner, engineer of the Florida East Coast Railroad, designed the welded structure and served as shop and field inspector for that company. The writer supervised the field welding for the Bethlehem Steel Co., fabricator and erector of the draw span.

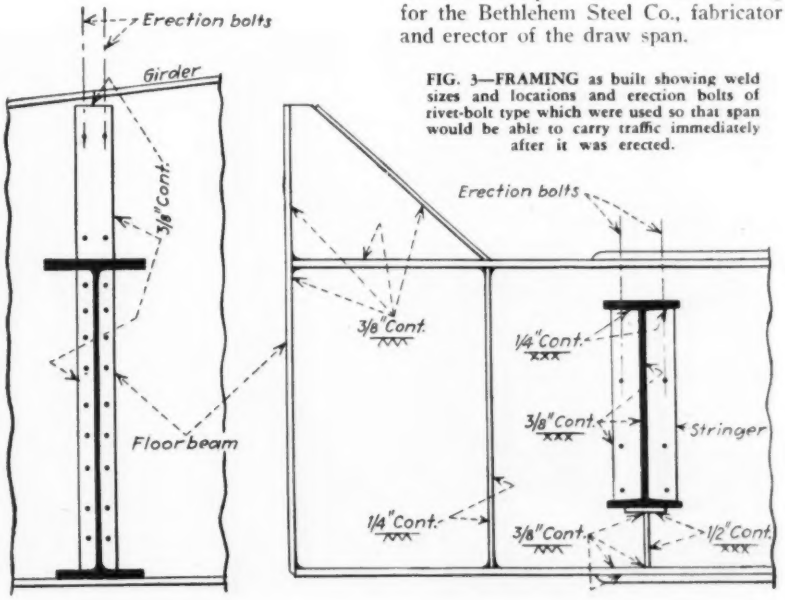


FIG. 3—FRAMING as built showing weld sizes and locations and erection bolts of rivet-bolt type which were used so that span would be able to carry traffic immediately after it was erected.

Concrete Bridge Pier Righted After Slide Causes Tilting

Gravity pulls pier back when excavation within cofferdam relieves earth pressure—Additional concrete around pier base forms retaining wall at toe of slide

THE PROBLEM of straightening up a 151-ft. concrete bridge pier that had been tilted out of plumb by a slide, recently was solved successfully on the Grand Coulee project. The bridge is a 950-ft. steel cantilever highway structure crossing the Columbia River just below Grand Coulee Dam. The pier on the right bank was tilted 9 in. out of line just before the steel superstructure was completed, as described in *Engineering News-Record*, Nov. 7, 1935, p. 646. Measures were taken to prevent further movement of the slide and with the pier still out of plumb the bridge was completed and put in service. Subsequently reconstruction work on the base of the pier, as described in the following, was completely successful in restoring the pier to its original position. The placement of additional concrete around the pier base is believed to constitute assurance against any further movement.

The plan for reconstructing the pier was to excavate around it within the protection of a circular cofferdam, thus relieving the earth pressure against the shore side, and then to build up within the cofferdam a block of concrete that would serve as a retaining wall at the toe of the sloping bank, to resist any further tendency to slide down against the pier. The first step was the driving of a steel sheetpile cofferdam 110 ft. in diameter with its center 20 ft. riverward from the center line of the pier. This eccentric position was to provide space for the additional width of footing which it was desired to place on the river side of the pier.

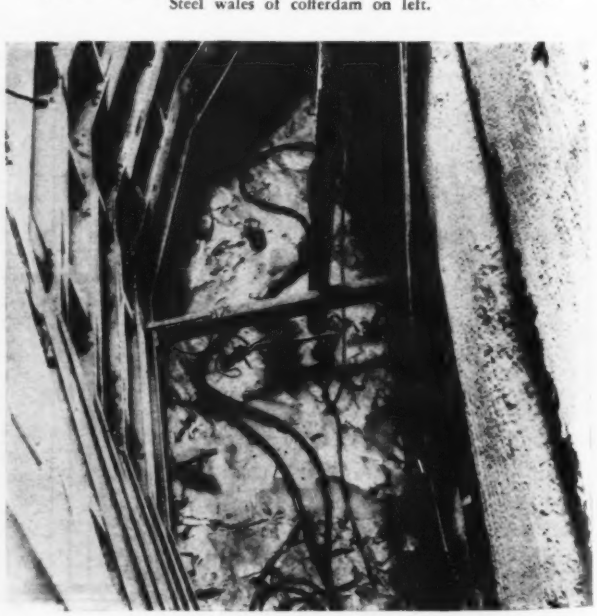
The cofferdam was started by leveling off the site to El. 940, which was about 5 ft. above river level at the time. Then the steel sheetpiling, circular in plan, was driven about 5 ft. below water level and excavation within it was begun with a clamshell. To brace the sheetpiling, interior segmental rings of 36-in. steel I-beams were put in. These ranged in weight from 132 lb. at the surface to 230 lb. at a depth of 65 ft. The vertical spacing between rings varied from 7 ft. at the top to 5 ft. at El. 900. The segments were 13 ft. long, were jacked tightly into place against the sheetpiling and there were welded, end to end, to make each bracing ring a complete and continuous circle. The jacking was done with 100-ton jacks braced against a ring of 36-in. 230-lb. I-beams suspended from above with segments parallel to those in the waling rings.

Proceeding in this way the sheetpiling was driven down to El. 900, excavation followed the driving closely and additional bracing rings were put in as the depth increased. At El. 900, under a water head of about 30 ft., while the work was shut down on Sunday, a blow-in occurred which quickly flooded the cofferdam. After slight additional driving it was found possible to pump out the cofferdam—the blow-in had not made any serious breach. However, the bottom of the sheetpiling was found to be bent inward, broken and split in some places and altogether unfit for further driving.

Accordingly, another circular row of sheetpiling was started inside the first, and the same driving procedure was followed. Within the smaller sized ring (the second circle was about 99 ft. in diameter) and as the base of the pier was approached, there was no room for jacks, so the I-beam walings were put in without jacking. In fact the jacking ring used in the upper section of the cofferdam, being of no further use, was cut to fit the lesser diameter of the sec-

FIG. 1—JACKING RING AND JACKS used to exert outward thrust on horizontal, segmental I-beam wales inside the circular sheet piling enclosure.

FIG. 2—EXPOSED FOUNDATION before new concrete was placed. Old concrete of pier, grooved for bond, on the right. Steel wales of cofferdam on left.



ond ring and was used for the first of the circular walings in the second section. After the inner ring of sheetpiling had been driven to bedrock a concrete seal was poured to insure effective closure between the outer and inner cofferdams. The total excavation within the cofferdam was about 19,600 cu.yd. Bedrock was found to be almost level and ranged from El. 872 to El. 875 in the area unwatered within the cofferdam.

As the excavation was being carried down and when it had reached a level of about El. 905 it was noted that the pier was beginning to set up pressure in struts that had been placed against it from the shore side. That is, the pier was giving evidence of a tendency to return from the leaning position into the original plumb position. When this tendency was noticed the struts were removed and care was taken to see that no thrust from the shore side reached the pier; the circular cofferdam was depended upon to carry the earth pressure.

From the 9-in. tilt observed at the top of the pier it was calculated that if there had been rotation along the river edge of the pier footing, the crack along the shore edge of the pier base would be about 1¾ in. wide. By the time excavation had reached the base of the pier the structure had settled back into an exactly plumb position and there was discovered

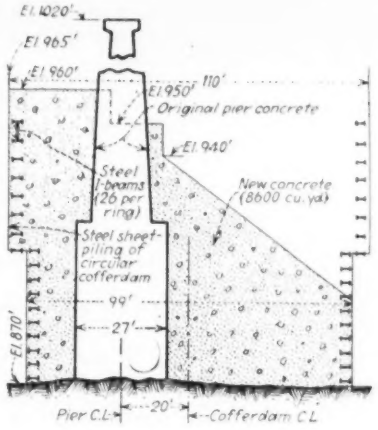


FIG. 3—ELEVATION THROUGH pier and cofferdam showing location of additional concrete with respect to pier structure.

on the shore side a few feet above the base a horizontal crack which, although it had closed by the time it was uncovered, showed the marks of spalling along the crack such as would be made by closure under considerable weight. It was suggested, therefore, that the soft mud surrounding the pier base had entered this crack when the pier tilted but had not prevented the crack from closing again because of the ease with which the soft material was squeezed out as the pier settled back into position. As the pier went back into plumb the 9-in. movement of its top was taken up partly in the expansion joints in the steel superstructure and partly by a slight shifting of the shoe transmitting the weight of the bridge to the pier top.

With the concrete bedrock uncovered, wood forms were erected in the plane of the upstream and downstream faces of the pier and inside these forms was poured some 8,600 cu.yd. of concrete, thus providing a concrete block with a sloping face on the river side as shown in Fig. 3.

As a final move to minimize thrust against the pier if any further earth movement should occur on the river bank, the steel sheetpiling in the cofferdam was cut with a torch along vertical lines on both sides of the concrete pier. This prevents the transfer to the concrete of any thrust that may later come against the outer part of the cofferdam.

The bridge pier construction was carried on by contract (J. H. Pomeroy, San Francisco) under direction of the U. S. Bureau of Reclamation: R. F. Walter, chief engineer, Denver, and F. A. Banks, construction engineer, Grand Coulee Dam.

Bituminous Road Practices Scrutinized

Montana conference of highway engineers gives bituminous roadbuilding practices a critical appraisal

A HIGHWAY DISCUSSION, conceived, planned and executed with the attention to detail, exacting demand for thoroughness and analytical development typical of the engineer, and that made distinct contributions to highway building was held at the Second Annual Montana Bituminous Conference in Glacier National Park, Sept. 8, 9 and 10.

The conference was unique in several respects; chiefly, perhaps for the manner in which the papers were presented. While twenty-one papers were prepared for discussion, only four papers were read. The four delivered were analytical and critical summations of the individual papers. Delegates to the conference were presented copies of all papers prepared and these, as well as the summations, were subject to exhaustive discussion from the floor.

Twenty-five western and mid-western states and the Province of Alberta were represented among the 400 registrants, and the delegations comprised a cross-section of roadbuilders — engineers, chemists, asphalt producers, oil technologists, professors and contractors.

The lead-off man in the conference, after the hospitable declaration of welcome, was L. D. Conkling, professor of civil engineering, Montana State College. His paper was a review of the bituminous field from the theoretical viewpoint with emphasis on the necessity of adding to available knowledge by application of generally accepted theories to everyday practice in order that the theories might stand up or fail in the crucible of service.

Research program planned

"The specifications in use of asphaltic materials," Professor Conkling declared, "are not entirely satisfactory for the reason that they do not depend upon characteristics of known relation to service behavior of road surfaces. Further research into the exact way in which asphalt performs its function of holding the aggregate together against the forces of nature and the loads imposed by vehicles should indicate tests directly related to this function. It is indeed a most complicated and intricate problem but we are not ready to concede that it is unsolvable."

While there has been a vast amount of research work performed, Professor Conkling pointed to the need for a central point of assimilation and service tests. The need of a more comprehensive bibliography was also emphasized.

Agreement of the conference with this feeling was emphatically revealed in the adoption of a resolution at the final session which is expected to result in the desired coordination and correlation of bituminous research through the Highway Research Board. The extensive program contemplated would be directed by the board, with specific problems attacked by the laboratory and field forces of the highway departments and the oil companies.

Another representative of the University in the roadbuilding problem was F. C. Lang, professor of highway engineering, University of Minnesota and engineer of tests, inspection and research, Minnesota highway department. Professor Lang's paper was a summary of papers prepared by individual engineers and chemists on the subject "Developments and Fundamentals of Successful Bituminous Practice."

The highly important place occupied by the base and subgrade in the success of the surface was the general theme of

the first papers in Professor Lang's summation—indeed the danger of expecting a good surface to overcome a poor base was emphasized again and again throughout the conference.

Virtually all serious or extensive failures of the bituminous type surface are easily traceable to failures of the base and subgrade to perform their assigned functions. Excessive moisture was recognized and condemned as the agency which most seriously interferes with the base and its load-carrying and load-distributing duties. Engineering fundamentals of the grade above the surrounding water table, and proper attention to other engineering fundamentals were accepted by the conference as the logical attack against excessive moisture failures.

Examining other "fundamentals" Professor Lang noted from the individual papers the existence of many and varied formulas favored by highway engineers in determining the proper relation between the amount and type of bitumen and aggregate. The use of any formula, he felt, indicates the importance of that particular problem and the necessity of its scientific solution. But the existence of numerous and sometimes conflicting formulas indicates a need for reconciliation of experience and more thorough analysis.

In the field of road building, said Professor Lang, even as in structures, emphasis must be placed on the need for closer and more understanding cooperation between the engineer and chemist.

Design and construction

The Bureau of Public Roads was represented on the program by N. F. McCoy, Highway Engineer of the Bureau in San Francisco, who summarized and commented on individual papers devoted to the subject: "Developments in the Practical Design and Construction of Bituminous Surfaces."

Mr. McCoy's paper essentially was a review of past developments of the bituminous surface. In it he stated that from the individual papers he had reviewed and from his own past experience he saw the trend to be for such surfacing to take its place as an intermediate type rather than the low type to which it is sometimes relegated. He saw too a tendency of the bituminous type surface to encroach steadily on the field which has been held by the high-cost types and to carry loads as high as 1,500 to 2,000 cars daily for costs approximating $6,000 to $10,000 a mile rather than the $25,000 to $40,000 a mile formerly considered necessary.

The northern approach to the Golden Gate Bridge in San Francisco, a roadway expected to carry an average of 5,000 vehicles daily, will be surfaced with bituminous material, Mr. McCoy said.

Base and subgrade were again emphasized as the real cause of many difficulties in Mr. McCoy's presentation. The experiments being carried on in Missouri and Oklahoma in stabilization of bases by sub-oiling were discussed and motion pictures shown.

The almost unanimous adoption of cutback asphalts and the practical elimination of the road oils or SC type materials, except as temporary surfaces and for waterproofiing, stood out clearly throughout the McCoy paper and was further emphasized in the discussion following. Even in the functions of priming and sealing the SC type materials find little favor.

In actual construction road-mix continues to be the method most widely used. A slight trend toward plant-mix was noted but because of its higher costs and usually little better results, plant-mix is expected to continue to account for a relatively small portion of the bituminous surfaces built.

Improvements in plant-mix operations were noted, however, with the addition of three and four bin separations, enabling a more elastic and more exact control of the mixture, being the most notable change. Road-mix methods have changed little but there have been vast improvements in road machinery and type of bituminous materials so that operations are speeded up, traffic caused less delay and inconvenience and fewer detours made necessary.

An interesting trend noted in McCoy's paper was the development of mechanical spreaders permitting the use of heavier asphalts. It was pointed out that this might logically result in the use of the familiar hot mix type which eliminates the use of solvents as the means of making the material workable. The discussion however indicated a belief that asphalts cut back by kerosene or naphtha solvents are more desirable and perhaps more satisfactory in their coating properties than those heated to workable consistency.

There was, nevertheless, a decided trend apparent toward the use of less solvent and heavier materials, made possible by developments in equipment.

Organized maintenance

The subject of maintenance occupied a place of its own on the program with H. G. Nevitt, manager, asphalt department, White Eagle Division, Socony-Vacuum Oil Company, acting as chairman of the division and summarizing the individual papers.

The maintenance policies and practices considered were from ten western and mid-western states having about 2,000 miles of bituminous surfaces each. The patrol or crew method of operation was indicated for routine maintenance, with a centrally controlled organization for larger operations, principally seal coating.

Closer designation of responsibility and further systematization was indicated as a desirable trend in many states. Making minor repairs immediately as the need arises was considered highly important.

The chief need in the field of maintenance is for a more thorough, exact and complete system of cost keeping. Practices varied widely among the states surveyed and frequently gave a distorted picture of maintenance costs. There should be a further differentiation between maintenance costs arising from different sources of failure. A need is felt too, for comparative costs on different types of construction and over longer periods so that maintenance costs can become a more dependable index of construction quality.

Seal coating as a means of preventing water seepage and excessive wear on the mat itself was considered highly essential and two types of seal coating were found in universal use. One, known as the paint-coat type, is used in many western states where cost is an important factor and where a cover is not believed necessary. The other type, occasionally referred to as the armor coat is applied with a chip covering to build up the surface to a white, non-skid character. A special RC cut-back has been developed for the paint-coat type of seal but the armor coat type has been applied with several different types of materials.

With the recognition of base and subgrade failures as the main cause of surface troubles and the determination to remove base difficulties, it will become more and more necessary to examine surface failures closely, analyze their causes and correct them. Closer control of costs will result from better record keeping and analysis.

The three-day conference was held in Many Glacier Hotel in the picturesque setting afforded by surrounding mountains, lakes, and glaciers. Typical Montana hospitality and entertainment provided a delightful contrast to the serious and technical discussions. The conference was voted to have adequately served its accepted function as a clearing house of information, developments and trends in bituminous construction. Next year's conference will be held in Yellowstone National Park.

Housing Progress in Illinois

STATUS and accomplishments of housing in Illinois, as noted in a semi-annual report of the State Housing Board are as follows: Demolition in Chicago has removed in 2½ years 8,597 badly deteriorated dwelling units in 3,439 buildings. Some 200 acres were cleared. Surveys indicate 21,555 additional dwelling units in 8,622 buildings beyond economic repair still stand in Chicago. No other Illinois city is tearing down unfit buildings nor is there any effort to enforce minimum standards. Housing shortages exist in all down-state cities, particularly for the low-income groups.

Power and Large Dams

Third World Power Conference and Second Congress on Large Dams held simultaneously in Washington—Power conference devotes its entire time to economic questions—Technical problems discussed at the dam congress.

BROAD ECONOMIC questions formed the basis for discussion of all the sessions of the Third World Power Conference in Washington, Sept. 7-12, while at the Second Congress on Large Dams, held concurrently, the attention of delegates and members was centered on a few specific technical questions of interest to all engineers concerned with the construction of dams, whether large or small. In all, 230 papers were prepared for the power conference and 90 for the dam congress. Nearly all papers were preprinted and made available to those who were to attend the sessions, thus freeing the sessions from the tedious presentation of papers and leaving the period assigned to each subject open for discussion. At each session a general reporter who had carefully reviewed the papers prepared for consideration at that session presented a summary of the papers for the information of those who had not read the papers.

Papers were prepared in any one of the four languages that were indicated as the official languages in the call for the meeting, English, French, German, or Spanish, and each was accompanied by a summary written in the other three languages. At each session, discussions similarly were in any one of the four languages. For the convenience of those unfamiliar with the language of the speaker each seat in the three auditoriums used for the sessions was equipped with head phones through which interpreters gave a translation of the speech. A dial on each set of phones made it possible to hear the speech in a familiar tongue by turning to the indicated point on the dial. However, discussions in a foreign tongue were not translated immediately into English through the translating system but were followed by an English translation presented by one of the interpreters directly from the speaker's desk. This system worked well in the power conference sessions but was of little use in the sessions of the dam congress due to the large number of technical terms and technical phrases that were unfamiliar to the interpreters.

Many economic subjects

Papers presented for consideration of the power conference gave a fairly broad coverage of the wide range of economic subjects laid down in the agenda, but discussion generally was on details or largely aside from the subject of the session. The subjects covered were as follows: national power and resources policies; national and regional planning and their relation to conservation of natural resources; significant trends in the development and utilization of power resources; planned utilization of water resources; utilization of small water powers; organization of the production, processing and distribution of coal and coal products and of petroleum and petroleum products; organization of the production, transportation, and distribution of natural and manufactured gas; conservation of coal, oil, and gas resources; organization and regulation of private electric and gas utilities; organization and financing of publicly owned gas and electric utilities; regional integration of electric and gas utilities, rationalization of distribution of electric energy and gas; rural electrification; and collection, compilation, and publication of statistics, with particular reference to international use.

Trends and planning

Twelve papers presented at the session devoted to national and regional planning in their relation to the conservation of natural resources were summarized by David C. Coyle, who acted as general reporter for that session. Mr. Coyle said that it was not possible to obtain from the papers a complete picture of what is taking place with regard to the many elements of conservation involved in such planning because each paper reflects chiefly the points of view of the author as regards the particular element of conservation in which he has a special interest. Further, Mr. Coyle said, the national approach to the problem varies widely in the several countries reporting due to their varied problems and diverse forms of government. Few countries have done any broad national planning for the conservation of all of their resources; rather, they have planned for a few resources that are of national importance.

Similar views were expressed by L. de Verebely (Hungary), the vice-chairman, in opening the discussion, who said that the problem of planning for the use of natural resources is quite different in a country like the United States with its unlimited resources, as compared with Hungary, for example, which lost most of its natural resources as a result of the World War.

Planning in Great Britain, said Sir Harold Hartley, has been concerned chiefly with the rationalization of industry and has been characterized by voluntary action on the part of industry, the government confining itself to aiding by the passage of needed legislation, rather than directing through the passage of mandatory laws. Thus the shipping and cotton industries both have cut their surplus capacity. Agriculture, insurance, and housing interests have taken similar concerted action to improve conditions in their particular fields. Compared with most other countries, said Sir Harold, there has been an unusually large amount of national planning in Great Britain and it has been surprisingly continuous as to general policy through many changes of government. This, he said, is due chiefly to the wide acceptance of the principle that there should be a minimum of government interference with business.

In Italy, said Marco Semenza, there is no distinction between regional and national planning; planning is national and is concerned chiefly with water power. Power development began with small plants using the unregulated flow of the rivers, with steam plants making up the deficiences. Subsequently, storage reservoirs were built, thus reducing the need for steam plants as the load on the system increased, and more recently larger and more efficient water power plants have replaced many of the small ones. By interconnection it has been found possible to get greater equalization of output due to the fact that flow conditions in the Alps region differ from those in the mountains farther south. The government has set up a commission to promote interconnection. Under existing laws, private companies in the same drainage area are required to cooperate to obtain the most efficient use of the water.

Opinions diverging widely from those generally expressed on the subject of conservation of national resources were voiced by F. K. T. van Iterson (Netherlands). Dr. van Iterson said that from a world point of view a high degree of economy in a nation's natural resources was questionable, that nations with ample and cheap coal resources, for example, should develop and sell them to nations lacking such cheap fuel. He said also that a nation like Holland with only low grade, costly fuel resources should not attempt to develop those resources

as a source of electric energy, but should import cheaper fuel to keep down the cost of power. Dr. van Iterson said further that a nation might go farther in the long run by being a little wasteful with its natural resources, citing the United States as an example.

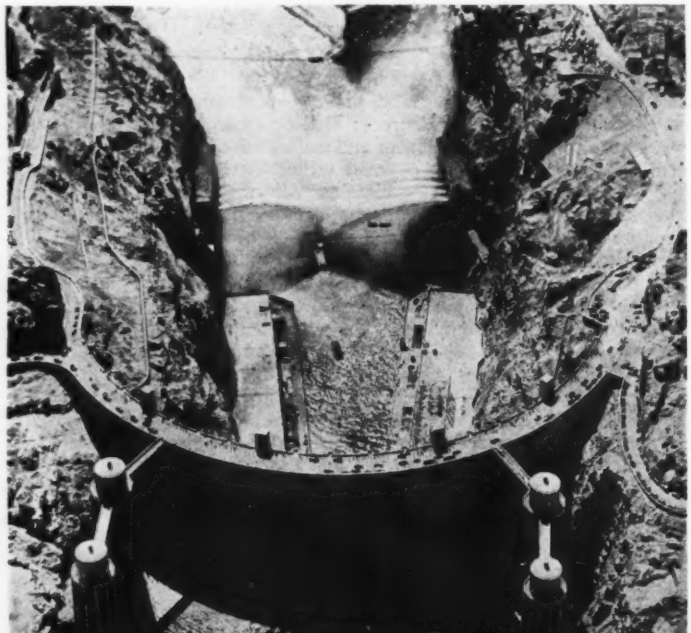
Planned use of water

The world point of view came to the fore again in the session on planned use of water resources when the vice-chairman, Nils Traaholt (Norway), in opening the discussion, said that from such an angle we must not only consider how best to use the water resources of any one nation, but must also determine how the surplus in one country can be used to make up deficiencies in a neighboring country.

Few of the papers presented for consideration at the session devoted to the planned use of water resources dealt with the subject broadly; most of them were restricted to water power and were confined chiefly to statistical information and to the amount of such power available in the several countries supplemented by an outline of the manner in which its exploitation is handled. Probably because of this limitation on the scope of most of the papers the general reporter for the session, Brig.-Gen. Max C. Tyler, did not attempt to summarize the papers in his report but confined himself to a general statement of the principles involved, supplemented by some details of federal planning for water resources in this country.

In the general discussion, A. Palluchini said that Italy has no broad plan for water use but has a very complete system for collecting hyrdologic data. By means of many gaging stations, some of which are automatic, the state collects records of both rate and amount of precipitation, also temperature, atmospheric pressure, and wind direction and velocity. The amount and rate of runoff also is checked. There are numerous stations for recording the condition of the underground water supplies.

The state water power commission of Sweden is not the outcome of a planned national policy, said Eric Upmark, as is stated in "Sweden—The Middle Way." Rather, he said, the commission simply is the natural outgrowth from the fact that a large number of the principal power sites of the country were on crown land at the time that water power began to become a factor in the national economy. The commission was set up to develop and administer the power resources belonging to the state. Of the power now developed, 30 per cent is state, 10 per cent municipal, and 60 per cent private. Municipal electric utilities and some large private undertakings work under a system of voluntary cooperation among themeslves and with the state. Mr. Upmark said that the success of the system that has grown under the Swedish law has had a pronounced influence on legislation adopted subsequently in adjoining states. The law, he said, fosters competition.



A SPECTACULAR TEST of the outlet works at Boulder Dam was made a part of the ceremony that marked the formal start of the power plant at the dam. Standing before the delegates to the Third World Power Conference in Washington, President Roosevelt, on Sept. 11, pressed a telegraph key that sent an impulse across the country to start the small station unit of 3,500 kw. capacity. At the same time, engineers at the dam opened the twelve 84 in. needle valves of the outlet works that will regulate the flow below the dam at times when the required amount is not passing through the turbines

N. G. Gedye (Great Britain), commenting on the paper submitted by Sir Alexander Gibbs, stated that since Sir Alexander's paper was prepared the joint parliamentary committee on water resources has submitted its report. Sir Alexander, in his paper, proposed that the exploitation of water resources in Great Britain be placed in the hands of a permanent central body having very broad powers. The parliamentary committee does not go so far in its recommendations. It proposes a widely representative central authority with much less power, chiefly for the purpose of correlating the recommendations of the nine existing water boards of Great Britain and to advise Parliament in all legislation affecting water.

Carl T. Kromer (Germany) raised question as to how best to handle power developments on international streams. He stated that dividing the work by plants, letting one country build one plant and the other a second, and so on, involved difficult problems of equalization of power output and cost, and stated that it appeared more desirable to carry on construction through some joint agency and to divide the generating equipment equally between the two countries, or to build separate power houses on opposite banks of the river, as has been done in some instances on the Rhine. However, he said this again involved problems of equalizing the use of the flow of the river. Mr. Kromer expressed the hope that the conference would bring out some information as to how this problem could best be handled.

In reply to this question, the chairman, F. B. Lewis, (U.S.A.) stated that the problem of planning for the use and development of an international river was little different from that of development of an interstate stream and cited the Colorado River Compact as an example of how that could be handled. He pointed out that the generating units in the Boulder Dam power house are allocated to the states to which they send power when the plant is completed.

Small water powers

Little of importance was brought out in the papers and discussions at the session devoted to the utilization of small water powers. The general opinion on that subject appeared to be summed up in the statement made by Henri Fredet (France) to the effect that the use of small water powers is declining and will continue to decline as electric transmission networks are extended. Small water powers are of no economic sig-

nificance in France, he said. The chairman, Abel Wolman (U.S.A.), said that the papers indicated a decline in the use of small water powers except in Sweden where the number of new plants of around 100 hp. capacity built in recent years exceeded those taken out of service. There the small plants are of importance in supplying small isolated communities and in building up the demand for larger plants. Similar conditions obtain in Bulgaria, said the vice chairman, D. Mamarchev. There, the small plant is of great economic value to isolated towns.

H. T. Cory and C. S. Jarvis, both of the U. S. Soil Conservation Service, expressed the opinion that there will be an increase in the use of small power plants in this country. Mr. Cory stated that headwater storage reservoirs would make many small power sites available for economic development, provided the cost of storage is distributed among the many beneficiaries.

James Williamson (Great Britain) said that the efficiency of some of the small power plants whose load demands have to be met by the developers of the Galloway power scheme in Scotland have been increased by the installation of more efficient turbines.

National policies

Discussion of national power policies that came up in the session devoted to that subject as well as in many other sessions brought out the interesting fact that only in this country is the subject of public versus private power development a matter of public discussion and controversy. All countries except Russia have both public and private power development to a greater or lesser degree, but in no other country is there a concerted effort to change the existing conditions. In Great Britain, said T. H. Minshall, municipal ownership is much more extensive than in the United States, but government ownership is not now urged. The joint parliamentary report, previously referred to, anticipates that in 50 years all utilities shall be subject to purchase by some government agency, if that then appears desirable. Colonel Minshall said that the middle way is believed to be the safest in Great Britain.

Pierre Lounay said that in France private industry is granted a large measure of control in the Council of Electricity but added that control of power is essentially a government problem.

The new public utilities promotion act of Germany, said Carl Krecke, is based on the principle that the national government should regulate but should not go into the power business. The government, he said, regulates power generation and distribution whether it be private or municipal enterprise.

B. I. Yusim (U.S.S.R.) was granted the privilege of the floor to outline how national planning of power resources is being carried on in Russia because the Soviet Government did not submit a paper on this subject. Russia, said Mr. Yusim, is the only country having a definite national plan for the development of its power resources. Under this plan, he said, the U.S.S.R. is developing the use of low grade fuels, is now using lignite and is building a plant to extract fuel from shale. The program of national economy calls for releasing the railroads from long distance haul of fuel through the development of local fuel resources. These include lignite, shale and peat. Peat now is widely usd in power stations, the problems of its use having been completely solved.

International Dam Congress Discusses Construction Details

WHEN the International Committee on Large Dams was organized as a subdivision of the World Power Conference at Stockholm three years ago a series of five subjects of discussion was outlined for the Washington Congress. This second congress meeting assembled at Washington last week, simultaneous with but independent of the sessions of the Third World Power Conference. In five separate sessions it discussed these five subjects:

Joints in dams
Facing of masonry and concrete dams
Special cements
Foundation studies
Stability of earth dams

A voluminous list of papers on each of these subjects had been prepared in advance and the papers for each session had been summarized by a general reporter.

Joints in dams

Design of expansion joints and the best method of providing for shrinkage in dams during construction was the subject of discussion at the first session of the dam congress. Hugh L. Cooper (U.S.A.) presided and Otto Henninger (Germany) acted as vice chairman. The eleven papers prepared for the session were summarized by R. E. Lapean (U.S.A.) in the general report for the session in which it was stated that "The consensus of opinions with respect to the necessity of contraction joints (as distinguished from shrinkage joints) is that such joints should be provided in all straight masonry and all concrete gravity dams. There are individual exceptions, notably that of Barton M. Jones (U.S.A.), but in the main the foregoing is the quite definitely established majority opinion.

"With respect to arch dams, there is a wider difference of opinion, commencing with an author who asserts the necessity, down through the opinion of another who maintains the necessity on the upstream face only, to the author who states that they are not necessary at all.

"The opinions with respect to the spacing of contraction joints agree almost unanimously that in concrete gravity dams the contraction joints should be spaced not more than 15 meters apart, although some authors advocate spacing as low as 12 meters.

"The recommended width of transverse shrinkage gaps varies from a minimum of 2 ft. to 8 ft., determined by the size of the structure. Some authors caution against transverse shrinkage gaps of too great width lest there result excessive shrinkage in the gap itself.

"P. W. Werner (Sweden) in his paper has presented an ingenious arrangement of steel reinforcement across shrinkage joints.

"There is not unanimity of opinion with respect to the superiority of flat as opposed to indented joints. Those authors favoring the latter indicate a preference for trapezoidal over rectangular indentations, for the reason that the latter may jam at the sharp corners and cause shrinkage cracks."

General discussion of the papers was preceded by a brief statement by the chairman as to the importance of the subject under consideration in which he referred to the fact that history records the failure of over 300 dams of relatively large size. Masonry dams should be elastic, said Col. Cooper, and each element of the structure should be able to withstand all the forces acting upon it. These forces cannot all be accurately measured but all can be controlled by proper design. Entire elimination of cracking due to expansion and contraction may not be possible, Col. Cooper said, but its reduction to an inconsequential amount should be an essential element of design. The crackless dam, he said, is an exception.

As important elements in the control of cracking Col. Cooper cited (1) use a water-cement ratio that will produce a slump of not over 1 to 1½ in.; (2) use low-heat cement; (3) make quality of concrete, not speed in construction the chief objective; (4) make large scale experiments to determine how much shrinkage must be provided for and fix the size of the individual "deposits" on the basis of the findings. Col. Cooper would eliminate the word "pour" from the dam-builder's vocabulary and would substitute the word "deposite."

Barton M. Jones, who was cited in the general report as not favoring expansion joints, said that Norris Dam

was built with shrinkage joints at 60-ft. intervals but with no expansion joints in the main body of the dam. When the shrinkage cracks have been grouted the structure will become in effect a monolith deriving added support from the abutments. Keyways should be circular in form, he said, because cracks begin to form at the reentrant angles of trapezoidal keyways. Mr. Jones stated that horizontal joints frequently are a source of trouble. He does not favor keyways in horizontal construction joints as they are difficult to clean and so tend to decrease the watertightness.

Adolfo Orive-Alba (Mexico) spoke on the subject of watertightness of the concrete facing for rock-fill dams. Whenever settlement is a factor, which is usually the case with large rock-fill fans, he said that a face such as that of Salt Springs Dam is not suitable as it lacks adequate flexibility. He favors a laminated form.

James Williamson (Great Britain) described in detail some of the designs for structures of the Galloway water power scheme in Scotland. Spacings of 50 ft. were used in horizontal arch dams, the shrinkage gaps being only wide enough to permit concrete buckets to enter easily. Mr. Williamson stressed the need for carrying expansion provisions through the foundations to the underlying rock. With modern cements and high-speed construction he thinks a 40-ft. spacing preferable.

Prof. Theodor Rehbock (Germany) spoke on the subject of expansion joints in arch dams giving the results of a study of a design submitted to him for approval in which the design assumptions were predicated on frictionless joints at the abutments. He condemned the design because it is not possible to build such a joint and without it serious stress conditions would be set up in the proposed structure.

Most types of expansion joints now in general use are satisfactory, said A. Stucky (Switzerland), hence more attention needs to be given to spacing and correct position than to type.

Types of copper water stops in common use in German dams were described by Otto Henninger.

C. P. Vetter (U. S. Bureau of Reclamation) expressed views that went quite contrary to those expressed by Barton Jones. He said that we design gravity dams as though made up of a series of thin vertical slabs free from end restraint, install expansion joints at intervals to give substance to this theory and then proceed to put keyways in these joints and grout them back to the waterstops, thus making monoliths in which horizontal beam action, never considered in the original design, may be fairly definite. He stated that expansion joints should be made so that they will maintain the blocks of which the dam is composed as independent elements.

N. G. Gedye (Great Britain) stated that the use of a metal waterstop, generally copper sheet, was widely favored in Great Britain.

Facing of dams

Means for checking the percolation of water through masonry and concrete dams and the protection of dam faces against damage due to temperature changes or floating ice or debris were discussed at the second session of the congress, at which Axel Ekwall (Sweden) acted as chairman and L. F. Harza, vice-chairman. Capt. T. H. Stanley (U.S.A.) acted as general reporter and presented a summary of the ten papers submitted for consideration. Taking up first the subject of reducing or eliminating percolation, Capt. Stanley said that this subject appears to have received greater attention in Europe than in this country. The use of asphaltic or similar compounds is quite general, sometimes reinforced by jute or burlap. Such coatings are comparatively inexpensive and easily applied but should be protected against abrasion. Coatings of mortar also have been used extensively in Europe, applied either by hand or by cement gun and either plain or reinforced by a metal mesh secured to the dam. J. Bolomey (Switzerland) does not favor hand application of the mortar coat.

High quality concrete also is used extensively in Europe for the upstream face of dams. Several authors stressed the need for making the concrete dense, preferably by vibration, both for impermeability and for freedom from frost damage.

On the subject of protection against the destructive effect of frost, Capt. Stanley stated that the authors did not consider that concrete even with a high cement ratio, could long resist alternate freezing and thawing without protection. For this as well as to check percolation, the use of a stone masonry facing, carefully pointed, is widely favored. In Switzerland, such protection for both faces is considered good practice, despite the added cost. The present-day tendency in France, according to A. Haegelen, is to use vibrated concrete of a high cement ratio for a depth of several feet along the upstream face of the dam, supplemented by impermeable coatings of cement mortar applied with a gun, by a bituminous coating or both. In high altitudes, French engineers favor the addition of masonry facing.

The Galloway project

Means used to obtain impermeability on the dams of the Galloway power project were outlined by James Williamson (Great Britain) in opening the discussion. There the cement content of the concrete to a depth of 2 ft. below the surface is doubled, the rich mix being placed concurrently with that for the body of the dam and separated from the leaner mix by steel diaphragms that are pulled up as the concrete rises, thus permitting the two to join as in a homogeneous mass.

Italy did not submit a paper on this subject until too late to be included in the general report, said Ettore Scimemi. The report covers observations on about 100 dams. The best results appear to have been obtained through the use of rich concrete; but it is not recommended for all situations.

Old dams that leak, said Mr. Scimemi, can be corrected by (a) cement injections or (b) by a facing of iron plates. Two Italian masonry dams have such a facing, one put on when the dam was built and the second ten years after construction as a last resort after all other means of checking percolation had failed.

N. G. Gedye (Great Britain) said that British practice is similar to that of American engineers, generally giving especial attention to the selection and control of materials going into the whole structure, and occasionally using a richer mix for the concrete near the water face. A cement coating on a suitable base has been found effective in some cases of seepage. He called attention to Mr. Binnie's paper on the Shing Mun River Dam in China. (An abstract of this paper will be published subsequently—Editor.)

Stone masonry facings

Both P. Renaud (France) and B. Hellstrom (Sweden) spoke of some difficulties involved in the use of masonry facings. Mr. Hellstrom stated that the conclusions of the general report that the use of masonry facings is accepted practice in Europe does not apply to Sweden. Most dams built 20 or 30 years ago had masonry faces, he said, but many have been badly damaged and some have been replaced with concrete. On many, the stones have been cracked and loosened by contraction and expansion. The use of fairly rich concrete in the whole mass is favored in Sweden, he said.

J. R. Davidson (Great Britain) referred to a masonry dam built in North Wales about 50 years ago in which the facing still is in perfect condition. In laying up the face the joints were left unfilled for a depth of 3 in. and subsequently were caulked with a very stiff rich mortar placed with caulking irons.

Facing not favored

Prof. Rehbock (Germany) supported the view that the whole structure should be of superior concrete rather than only the upstream face. The same observation was made by Col. Cooper who said that the use of a facing is a mistake, and that a concrete dam can be made absolutely tight without a facing. If the concrete itself is impervious and is not deposited so fast that the heat of hydration causes abnormal shrinkage the dam will be tight. Leakage, he said, fre-

quently developed through shrinkage cracks that originate in the faces. To prevent their formation he favors the creation of shallow joints to take up the surface expansion, the joints being formed by inserting a tar-paper diaphragm to a depth of about 3 ft. below the surface.

Special cements

With B. Hellstrom of Sweden presiding, a notably active session was held on the subject of special cements. Seventeen papers, from Japan, Great Britain, U.S.S.R., Austria, Norway, Sweden, Poland, Czechoslovakia and Italy were summarized by R. F. Blanks for J. L. Savage, Denver, general reporter.

According to Mr. Blanks the trend toward high early strength in cements and rapid construction of dams, leading to high internal temperatures and extensive cracking (in some cases disintegration requiring repairs), brought special types of cement to the fore. The leading requirements, as given by papers from various countries, are minimum heat of hardening, slow setting, good workability and low segregation, high strength, density, and resistance to aggressive waters. The cements used or tried in various countries under these conditions include low-heat, moderate-heat, silica cements, portland-puzzolan cements, water-resistant cements, aluminous cements, and iron cements. England reports one dam built with a special cement, Sweden three (two with puzzolanic admixture), Japan one, Italy one, United States six, (two low-heat, three modified, one puzzolanic admixture). A universal interest in special cements is found throughout the world. American studies and experience indicate that compound composition and fineness are important factors.

The interesting fact was reported from Norway that seven important dams had to be completely rebuilt because of poor concrete; freezing effects and acid waters are especially troublesome, but only standard cement is used. In Sweden, high silica cement has been used in a number of dams and other hydraulic structures, with the result of showing less cracking than ordinary cement.

In discussion, N. G. Gedye (Great Britain) asked that an international commission be set up to draft specifications for one or more special cements. O. Graf (Germany) said that German engineers are preparing to drop the tensile test for a bending test, with special hope to check the effect of drying on strength. The influence of hydraulic admixtures might be large in mortar but small or absent in concrete, he also claimed. Viscount Falmouth (Great Britain) expressed a hope for a universal specification for special cement.

P. H. Bates (U.S.A.) referred to the flood of special cements now appearing and asked whether we will finally have a special cement for the downstream and another for the upstream face of a dam, or one for the north side and one for the south side of a road. He pointed out that the volume change in the first 24 hours produces the principal strains in concrete. Referring to its properties he said we need to think more of the quality of cement *in concrete*. A. Ruettgers, Denver, said that special cements are here to stay and remarked that the influence of cement on heat generation varies widely with placing conditions. L. Forsen (Sweden) did not agree with other speakers and authors that high fineness is essential, but said that low-heat cement can be obtained from coarse grinding, with the advantage of a slow set and a long gain in strength. In his opinion specifications should be limited to the requirements as to heat, strength, and the related physical properties. A. Ekwall (Sweden) reported the case of a draft tube of a very large turbine, with high suction head, where water and air tightness was essential, in which case a low-heat cement with diatomaceous addition was used; the concrete is tight and has absolutely no cracks.

M. Mary (France) reported large variation between different cements in permeability tests. Sir Harold Hartley (Great Britain) expressed the view that more fundamental work is necessary before satisfactory specifications can be prepared.

Methods of measuring heat evolution were discussed by S. Giertz-Hedstrom (Sweden) and E. J. M. Honigmann (Austria).

Foundation studies

A somewhat briefer discussion was given to the subject of foundation studies in a meeting presided over by Prof. Glennon Gilboy, Cambridge, Mass. Irving B. Crosby as general reporter summarized the eleven papers submitted by delegates from France, Switzerland, Great Britain, Japan, U.S.S.R., Germany, Sweden and the United States.

The importance of advance geological investigation of dam sites is universally accepted. Attempts to classify rocks for foundation qualities have been made. The danger arising from old valleys buried under glacial deposits and the need for percolation studies in pervious ground are recognized. Geophysical explorations have proved informative in a number of practical cases. Tests of the strength of foundation materials appear to be imperfect as yet, in the case of both rock and loose ground. Grouting to correct foundation condition (with cement, asphalt, clay and chemicals), receives very thorough attention throughout the world. Cutoffs and blanketing are also used to improve foundations.

A. Mayer (France) reported an unusual distribution of compressible soil under the Ghrib dam in Algeria, where settlement up to 2 ft. occurred; the observed settlement agreed almost precisely with that computed from the properties of the soil.

James Williamson (Great Britain) cited examples of failure of borings to reveal rock pockets and gorges; he remarked that "illogical investigations are very much more reliable if made after the excavation is taken out than if made before." G. Drouhin, France, reported several cases of foundation difficulties with dams in Algeria, in one of which the weak subsoil was consolidated after completion of the dam by loading the crest by jacks against an anchorage of cables passing down into the rock through holes bored in the dam. T. Rehbock (Germany) described a defective foundation of a new dam on the Cubuk River for the water supply of Ankara, Turkey, where a section of the dam stopped at the top of decayed rock and the pier footings below this point to sound rock were of inadequate width; a large toe extension had to be built. The case was reported as one of inadequate advance exploration of the subsoil. The treatment of a weak shear zone in the rock under the Schuschlee Dam in Germany by filling it with a concrete plug grouted tight was described by O. Henninger (Germany).

Earth dams

Devoted almost entirely to matters of stress geometry and analysis of soil action, the closing session of the congress, devoted to the stability of earth dams, proved to be one of the most active. Brig. Gen. G. B. Pillsbury (U.S.A.) presided, and William P. Creager (U.S.A.) was general reporter who summarized the fifteen papers submitted by delegates from Switzerland, Japan, France, Germany, U.S.S.R., Czechoslovakia, Sweden, Italy and the United States.

Stability of dam slopes was the subject of the majority of the papers. The most complete discussions were offered by W. Fellenius (Sweden) and T. T. Knappen (U.S.A.). The foundation stability was especially discussed by Prof. Glennon Gilboy (U.S.A.) who presented exceptionally simple equations applicable to shallow and deep foundations respectively. Special emphasis was placed by A. Mayer (France) on the risk of sliding after rapid drawdown of the reservoir.

J. Frontard (France) in discussion distinguished between "dangerous" and "catastrophic" heights of embankment.

A Fellenius (Sweden) urged that the stability of the mass rather than of the slope be considered. The importance of checking earth dam theory by observations on actual dams was urged by Brito Filho (Brazil) who proposed a group of Brazilian dams to be built under a new construction program as test objects. For the rest, the discussion dealt mainly with mathematical detail of earth slope failure phenomena.

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EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, N. A. Bowers, W. G. Bowman, W. W. DeBerard, C. S. Hill, H. W. Richardson, E. J. Cleary

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Power from Boulder Dam

BY COINCIDENCE the first unit of the power installation at Boulder Dam was completed ready for operation in the closing days of the World Power Conference, held at Washington last week. It was appropriate that the official starting of the unit was performed at a conference session, since it symbolized the accomplishment of a great work of public service that was rendered practicable by its power element. The unit started is only a station service machine, not intended for outside power supply, and because of this fact the occasion has little more than formal significance; nevertheless it is a milestone in Boulder Dam's history as the first actual conversion of the stored energy in the reservoir into usable power. Within a month, moreover, the first of the main units is to go into service. Thus, barely six years have brought the tremendous undertaking to that stage of completion where it accomplishes not only flood protection and the abolishment of water famine in the irrigated valleys below but also produces power. Arthur Davis, father of the project, and Elwood Mead, who guided it through its actual initiation and construction, did not live to see the accomplishment, but the many others, engineers, contractors and citizens who joined in making the project a reality may justly take pride in its completion.

The First Essential

OF THE ELEMENTS of dam construction practice discussed in Washington last week at the Second International Congress on Large Dams, the study of foundation conditions unquestionably leads in importance. A good foundation is the first essential of dam construction. More dams have failed because of bad foundations than from any other cause, and even though foundation conditions today receive far more thorough attention than formerly yet it is a fact that nearly all the dam disasters of the last decade were brought about by foundation defects. The subject of foundations, however, received no more attention at the meeting than did other and less important subjects. In the interests of progressive increase in dam safety we venture to express the hope that foundations will be given a permanent place in the list of future congress themes and will be discussed at each succeeding meeting at least until such time as rock weakness, underflow and erosion have been much more amply illuminated than they were at Washington.

Cement Improvement

DURING THE PAST TWO WEEKS the subject of cement improvement has again come into the limelight strongly. The Second Congress on Large Dams devoted a full session to special cements and in addition issued a report on test methods; the Bureau of Reclamation published a voluminous report on its cement researches, together with notes on the use and behavior of special cements in a number of structures from Morris dam to Bonneville; and a preliminary draft of proposed federal specifications for a group of special cements was completed. These three events strongly emphasize the trend of thought among engineers who use cement: They are seeking actively for such improvement in the material as will correct various defects in present-day concrete practice, though proof is not yet conclusive that these defects are chargeable primarily to the cement. It is probably true that, as one engineer stated at the dam congress, special cements are here to stay, but for the present the congress proceedings leave no doubt that even the restricted question of what cement quality is best for large dams—if indeed this service requires a distinct type of cement—is by no means decided. In this interesting situation a divergence that appeared at the congress is especially important. Some European cement users argued for specifying test properties only, while the majority of American representatives held that cement composition should also be specified. If, as some of the evidence suggests, various types and compositions of cement can give the same test and service results it may prove possible to solve the difficulty by specifying only the desired properties of the cement. This however calls for a refinement of cement testing well beyond present practice.

Scrap the Narrow Bridge

TOO SMALL A PROPORTION of our highway expenditure is being applied to bridge modernization. As a consequence too many accidents occur as a result of narrow bridge roadways that have been allowed to remain on an otherwise modern highway. Even if the road itself has not been widened, the bridge often forms a constriction, for it was built in the horse-and-buggy days when narrow bridges were not the hazard that they are now with high-speed motor cars. Last week we reported an accident in Virginia in which a truck missed a 12-ft. roadway on a steel pony truss, wrecking the bridge and resulting in four deaths. The bridge was on what would be termed a main highway. Virginia bridges are no worse than those in any other state so that the same kind of accident may be reported from the north, the west or the east next week. The narrow bridge is a universal hazard that has been neglected in the desire to increase road mileage and to defer the large expenditure required for a new bridge until such time as the money can be "spared." The next major step in road building should be bridge building. The narrow bridge must be scrapped in the interest of safer highways, good engineering and sensible road administration.

Drought and Roads

THE ROADBUILDER'S CONCERN with drought is not a subject to which many persons are likely to give thought, for in comparison with the vital importance of normal rainfall to water supply, irrigation, power and even navigation the effect of prolonged dryness on highways is small—although it is far from negligible and is being voiced in construction reports from the drought areas. Absence of rain, dry streams and subsiding groundwater are not unmixed evils in roadbuilding; dry streams indeed have been a boon to the road bridgebuilder, and his affairs have flourished out of ordinary measure. So also the concrete roadbuilder is cheerfully going farther afield for his mixing water in consideration of the long grant of rainless days for uninterrupted concrete mixing and placing. But the tale is different in the case of grading,

or placing gravel and stabilized soil surfaces; lack of moisture makes it difficult to solidify fills and compact wearing courses. The dust binder also blows away, making replacement necessary later on, when rain provides the necessary water for solidification. As existing gravel and earth surfaces are losing their fine material at an accelerated rate, increased maintenance work may be anticipated. The cost of the drought to roadbuilders must run to a surprising total.

More Power

LITTLE of the sterile political controversy that some had feared might become the outstanding feature of last week's World Power Conference rose to mar the proceedings. Instead, the conference brought to light two or three facts of great significance. First, that the world needs and wants more power. In the light of this revelation the programmed discussion of procedure and administration were of only incidental concern; all of the active thinking turned on the theme of more power.

The second fact is that a virtually universal shortage of power facilities exists. Throughout the civilized world, it appears, the depression bore heavily on power-supply systems, cutting their consumption, paralyzing their growth and befogging the outlook so badly that none could venture to expand, hardly even to maintain. Now that consumption has rebounded from its low and has passed its prior peak, existing plant is found to have little margin left; it is evident that a great expansion of power plant is ahead all over the world.

Even more important than the need for more power to supply present use is the strong demand for extension of power use. This springs from a widespread consciousness, apparently rather newly developed, that power is closely related to human progress. Every country, it seems, has become convinced that its wellbeing depends on achieving a larger use of power by carrying it to more consumers and putting a greater number of kilowatt-hours into every pair of hands. It realizes that more power means increased production and this in turn means more wealth for all; that lessening of toil and wider distribution of necessaries, comforts and enjoyments are obtainable in no other way than through greater utilization of power.

It is interesting to observe that this practical philosophy has taken root in the face of much preaching against labor-saving methods and for return to handwork production. In the long run such preachments could not prevail against the instinctive knowledge that we cannot produce and have more if we make production more toilsome. The Third World Power Conference has now crystallized this knowledge into a definite conclusion. The two prior conferences accomplished nothing comparable, perhaps because they were occupied chiefly with technical and administrative detail. The organizers of the Washington conference, rightly perceiving that the effect of power on national economy has become of supreme importance, shaped their program accordingly, and so enabled the picture of the demand for more power to emerge clearly.

The conference had the advantage of meeting in a country that stands at the top of the list in power wealth. Our large per capita use stood in sharp contrast to that in all but a few countries represented and demonstrated to the visiting delegates that they can multiply their market. At the same time there is little doubt that our own opportunities for power growth also are great and that, quite as in other countries, the extension of power use gives rise to important problems. But the conference indicated that in solving these problems little use can be made of the methods adopted elsewhere. It showed that governmental, industrial and resource conditions differ so widely in the various countries that their power problems are unlike, and the policies and methods of each must necessarily be adapted to its own needs. Thus a third important fact was brought out: that the most efficient management of power resources will have to be worked out by our own abilities with little regard to practices abroad.

Neglected Hazards

FOR YEARS the water-supply profession has devoted its best energies to assuring the purity of our community water supplies. By progressive refinement of water-treatment processes it has succeeded in furnishing consistently a product free of contamination, and the toll of water-borne disease has been all but abolished. The progress made is well pictured in the record presented by M. N. Baker in his article in this issue. But the record can not be declared satisfactory while water supplies continue to carry the hidden dangers of cross-connections and faulty plumbing. The time has come to take determined action to remove this remaining menace.

That cross-connections and bad plumbing are the weak spots in the protective armor of water supplies is no new fact; on the contrary their disregard has long been under indictment as a matter bordering on criminal negligence. Apparently the lessons of the past, and especially of the Chicago amoebic dysentery epidemic of three years ago, in which 98 persons died and 1,409 were infected, have been forgotten by all but a few, for the fact remains that the hidden hazards of cross-connections and defective piping that exist in every water-supply system are potentially capable of repeating the Chicago experience on even larger and sadder scale.

Whenever an examination is made the revelations are shocking beyond description. For instance, in a recent examination of a hospital in one of our eastern cities, it was found that the sterilizing pans in the operating rooms were so connected that any drop in water pressure would permit their contents to be sucked directly into the supply mains. Sewage treatment plants are notorious offenders in the matter of cross-connections, and there are stated cases in which not only can back-siphonage take place but in addition raw sewage and sludge can be pumped directly into the water supply system!

If these examples illustrate conditions revealed by sporadic and limited examinations, what would be unearthed if thorough campaigns covering entire systems were conducted?

Every water purveyor must be aware of the incongruity of a situation in which insistent emphasis is placed on efficiency of treatment and sterilization processes but in which the most likely, most easily accessible focus of contamination—the cross-connection—is ignored. He should recognize also that his apathy toward forcing measures of reform is still more incongruous. The responsibility of safeguarding water quality at its source and at its destination is not a divided one; if the waterworks profession continues to ignore the latter it fails in faithful discharge of its fullest obligation.

CURRENT NEWS

New Tunnel Work Advertised For George Washington Bridge

Bids have been asked by the Port of New York Authority for Oct. 14 covering fans and motors for the vehicular tunnel approach to the George Washington Bridge. This tunnel located in West 178th St., Manhattan, and some 2,200 ft. long, was built in 1931 with the other bridge approaches, but, in accordance with an agreement with the city of New York, was not to be completed and put in service until traffic warranted. The first contract, looking toward a completion date at about the end of 1937, was let in the fall of 1935, covering extension of the tunnel under Amsterdam Ave. to an entrance and exit plaza in High Bridge Park; this work is practically complete. Russiano & Son, New York, is the contractor. The fan and motor contract is the second to be advertised.

The tunnel as built extends from an underground plaza near the bridge head at Fort Washington Ave. eastward to Amsterdam Ave. It consists of a box about 40 ft. wide and 20 ft. high, built of steel bents and concrete jack arches. In this box, whose roof is only about 5 ft. below street level, the air ducts are located one above the other, at one side of the 22 ft. roadway.

The next contracts planned are for a ventilation building and for completion of the Fort Washington plaza and the street connections. According to present tentative plans, electrical work will be advertised about March, tunnel paving about June, and miscellaneous work including tile lining, about July, 1937.

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Public Works Convention Will Meet at Toronto

Problems of public works administrators, staff engineers, and operators are included in the 4-day program of the Public Works Congress to be held Sept. 28, 29, 30 and Oct. 1 at Toronto, Ont. Under administration, there will be a symposium on water departments, billing and accounting, records and enforcement of cross-connection regulations, and papers on management of a sewage treatment plant and training for public service. For the engineer a long list of topics has been provided, including planning surveys, paving research, airports, traffic control, industrial waste, garbage, sewage, and housing. Subjects of special interest to the operator include progress on two manuals, street cleaning and refuse collection and disposal. A panel discussion on public works operation will be participated in by six operation officials.

In accordance with a request from both societies at last year's conference, a plan for consolidation of the American Society of Municipal Engineers and the International Association of Public Works Officials into a new public works organization will be presented by the joint administration board.

First Allotments from New PWA Money

President tells the Associated General Contractors that PWA will go forward without interruption

ON SEPT. 8 and on Sept. 12 allotments of $7,438,338 and $7,721,116 respectively as well as loans of $317,000 and $195,000 were approved by President Roosevelt. Funds for the Sept. 8 allotments, which were noted briefly in *ENR*, Sept. 10, p. 389, were drawn partly from the new appropriation of $300,000,000 made by the last Congress. The Sept. 12 allotments were the first to be made wholly from the new appropriation. All of these grants were for 45 per cent of project cost.

Most of the projects on the new allotments are quite small. The largest is a grant of $3,600,000 for construction of the new charity hospital at New Orleans. There is also a grant of $2,110,950 for elimination of grade crossings at Elizabethport, N. J., and some other work.

Assurances that the $300,000,000 program of non-federal Public Works Administration projects "will go forward without interruption" were given by President Roosevelt in a letter dated September 8 to Rep. Alfred F. Beiter of New York. Rep. Beiter led the fight in Congress to earmark the $300,000,000 for projects of the PWA type.

The letter was written when Rep. Beiter forwarded to the President a letter he had received from Edward J. Harding, director of the Associated General Contractors of America pointing out that the best construction season is slipping by and asking what could be done to get the program under way "in accordance with the terms of the authorization and the intent of Congress."

The full text of the President's letter follows:

"I have your letter of Aug. 21, with which you inclosed a communication that Edward J. Harding, managing director of the Associated General Contractors of America, wrote you.

"The Associated General Contractors have shown a keen interest in the public works program and I am not unmindful of that interest. You may tell Mr. Harding that from time to time I shall continue to approve additional projects for inclusion in the Public Works Administration program, which will go forward without interruption.

"Recently I approved PWA projects amounting to approximately $22,000,000, on which construction will start within the next few weeks. I expect to announce an additional group shortly.

"As all these projects will be constructed through the agency of general contractors, I am sure that they will have a beneficial effect upon the construction industry."

Revised rules and regulations have been drawn up to cover work on the new program. They will be made public within a few days, it is stated at PWA offices.

Architectural Competition For New York World's Fair

In the hope of discovering unknown talent and as a guide to the selection of architects to design buildings for the 1939 New York World Fair, the World Fair Corporation has announced an architectural competition. The competition is open to registered architects having a residence or office in the New York metropolitan area. The first prize will be $1,000 and a commission to design a building for the fair. There will be second and third prizes of $750 and $500 respectively, and 20 honorary mentions of $100 each. Prize winners other than the first will be given consideration as designers for fair buildings on a fee basis.

The competition is for the design of one of a group of buildings. It will be a one-story building of frame construction covered with plaster or plaster board inside and with an outside surface of plaster board or stucco. The building will be used for public exhibits in the field of applied arts.

All entries must be submitted before Oct. 6. It is expected that the award of the jury will be announced by Oct. 20.

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Exhibits Show Power Development in U. S. A.

For the benefit of delegates and visitors to the Third World Power Conference a large number of exhibits visualizing the U. S. power industry were on display, sponsored by trade associations in the power field and by various government departments. These, for the most part, consisted of photographs, charts, and other devices, including an interesting series of three-dimensional load graphs depicting the living habits of the inhabitants of various cities as revealed by electric power consumption.

A number of the exhibits were so unusual as to merit special mention. The Corps of Engineers displayed a complete scale model of the Bonneville project on the Columbia River, showing in minute detail the entire plant, even to the fish ladders and power-plant equipment, as well as the surrounding topography. The Corps also had on display a working model of a typical Mississippi River rolling dam. A scale model of the Richmond steam generating station, built at a cost of $1,500, was displayed by the Philadelphia Electric Company.

Large maps, some with electric lighting, were used to good effect. Major generating plants, classified according to source of power, were marked on a large map by vari-colored lights in the exhibit of the Federal Power Commission. The Bureau of Reclamation by diagrams, drawings and photographs showed the extent and character of its operations. The Power Division of the Public Works Administration outlined the development of public power districts in Nebraska by a similar device.

Telephone lines throughout the United States were outlined in colored light by the Chesapeake and Potomac Telephone Company. Other map exhibits illustrated graphically the work of the Tennessee Valley Authority and power-reclamation developments in Puerto Rico.

Upper Mississippi River Reopened to Navigation

With the drought widely broken throughout the middlewest, the Upper Mississippi River has risen sufficiently that movement of river freight has been resumed by the Federal Barge Lines of the Inland Waterways Corporation.

On Sept. 12 the stage of the Mississippi was 2.0 ft. at Davenport, Ia. A six-foot navigable channel existed below the Twin Cities. Aug. 14 this year the river reached an all-time low for the navigation season when the stage at Davenport was —1.0 ft.

Planning Board For Island of Montreal

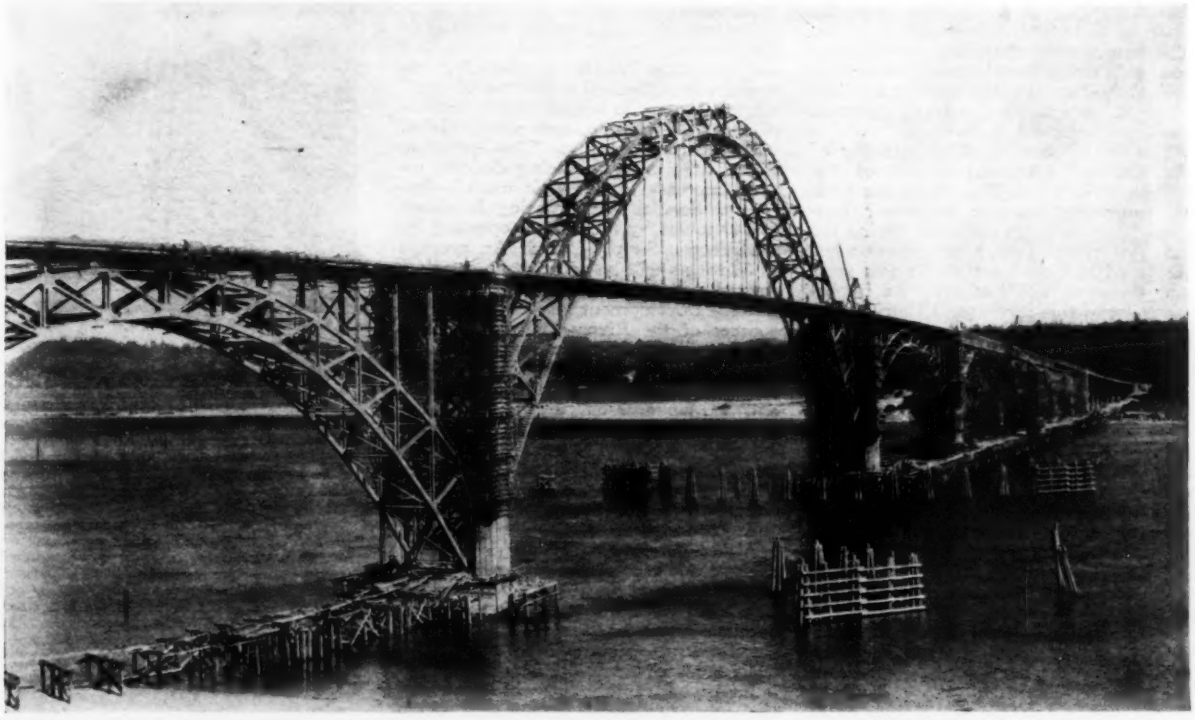
H. A. Terreault, chairman of the Town Planning Commission of the city of Montreal, has been appointed to head the new committee on planning and research which is being set up by the Metropolitan Commission of the island of Montreal. The commission consists of representatives of all municipalities on the island of Montreal, including the city of Montreal. The work of the new committee will be coordinated with the work of the city's Town Planning Commission. The functions of the committee will be, at first, the collection of statistics on all matters of public service, industrial progress, public works, highways, etc., and the arrangement and publication of these as a basis for further studies. Among the matters which the committee will be called upon to consider will be the relative merits of the two routes for the new main approach highway to the city of Montreal from the west end of the island.

Permanent Harbors Board Appointed in Canada

A permanent National Harbors Board, consisting of three members, was appointed on Sept. 8 by the dominion government of Canada. The newly appointed board replaces the temporary board appointed when the new system of governing Canadian harbors went into effect last fall.

Ralph Campney, a lawyer and one-time member of the Prime Minister's secretarial staff, has been named chairman of the board. A. E. Dubuc, chief engineer of the department of railways and canals, and B. U. Roberts, assistant deputy minister of finance, are the other two newly appointed members.

Last fall the local harbor commissions were abolished and a temporary National Harbors Board established, with jurisdiction over all harbors in the dominion. Under the new system each harbor in the Dominion will be governed by a port commissioner who will be appointed by the National Harbors Board.



OREGON OPENS FIFTH AND LAST BRIDGE ON COAST HIGHWAY

With the opening last week of the bridge over Yaquina Bay, the state highway department of Oregon eliminated the last ferry on its Coast or Redwood Highway (U.S. 101), and completed the most ambitious bridge building program in its history. Five bridges financed as a unit by a $5,602,000 PWA loan and grant have been constructed since 1934 along an 80-mile length of this highway, each crossing a bay or a river mouth previously serviced by a ferry. Tolls on the bridges will retire the $3,993,000 loan in 28 years.

The Yaquina Bay bridge located near Newport has a total length of 3,260 ft. in which is included the 600-ft. steel arch, pictured above, whose under-clearance of 135 ft. was designed to pass coastwise navigation. Sixteen miles south is Alsea Bay crossed by a bridge about 3,000 ft. long in which the main channel span is a 210-ft. reinforced concrete arch providing 70-ft. shipping clearance; the flanking spans are 150-ft. through concrete arches, and in addition there are six 150-ft. deck arch spans. Thirty-five miles below Alsea Bay, the mouth of the Suislaw River is crossed by a bridge 1,649 ft. long in which the channel span is a 140-ft. double-leaf bascule flanked at either end by 154-ft. through reinforced-concrete arches. Then 21 miles farther south near Eastport the Umpqua River is crossed by a bridge 2,213 ft. long which includes a 439-ft. steel swing span over the shipping channel flanked at either end by two 154-ft. through reinforced-concrete arches. Last and most southerly of the five bridges and also the longest (5,338 ft.) is that over Coos Bay which includes a steel cantilever with 793-ft. main span and 458-ft. anchor spans. In addition there are 13 reinforced-concrete deck arches as well as concrete girder approaches.

A number of interesting design and construction features characterize the bridges. These are described in an article in *Engineering News-Record*, Nov. 14, 1935, p. 677, and include Considere construction hinges on all of the concrete deck arch spans, the use of structural steel compression stubs and fabricated steel tension ties in all of the through concrete arches which are of the bowstring type, the use of balanced erection about the main piers of the Coos Bay steel cantilever, and special attention to the architecture of the piers of the several bridges. The self-liquidating plan under which the bridges were built was outlined in *Engineering News-Record*, June 6, 1935, p. 814.

Power Conference Sidelights

Power resources, developments, and needs of countries throughout the world as revealed by interviews with delegates to the World Power Conference

AUSTRIA: The main lines of most of the railways in Austria are now electrified; and the program of electrification is to be continued. Only 20 per cent of the water power resources of the country, which amount to about 1,000,000 hp., have been developed. All power produced in Austria is generated by water.

Brazil: F. Saturino de Brito Filho, states that a reclamation and irrigation project costing about $47,000,000 is now under way. The project will require about ten years for completion. The government-owned Central of Brazil Railway is being electrified and other railroads of the country are planning to electrify parts of their systems within the next few years.

Britain: Coordination of the small generating units scattered through the country is Britain's chief power problem, according to R. C. Milzner of the staff of Standard Telegraph & Cable. There are more than 600 power companies in Great Britain, and the work of eliminating the smaller, weaker, and less efficient, which has already started, must be continued, he believes.

Harold Hobson, general manager of the Central Electrical Board of the British Grid states that there has been an enormous increase in power consumed for domestic purposes during the past few years. Power consumption has increased 16.7 per cent so far this year, and domestic use has been an important part of this increase. Electrification of railroads is just beginning. Several railway electrification projects are now under way.

Chile: Lack of private capital will lead to development of the power resources of Chile by the government, in the view of Carlos Hoerning, professor of industrial engineering at the University of Chile. The Santiago area, he said, must have additional power soon; power will probably be obtained from the Miapo River, which is already developing 140,000 hp. Chile must depend largely on hydro-electric power since domestic coal supplies are inadequate.

Colombia—Julio Carzon Nieto states that the potential water power resources of Colombia are very great. At present the great electrical needs are domestic rather than industrial; the smaller cities are in need of lighting, refrigeration and transportation. Electric lighting is now generally confined to the larger cities.

Costa Rica: Juan Jose Bolanos, municipal engineer of San Jose, states that further development of power in Costa Rica is necessary to meet the needs of the coffee fincas where power is needed for drying purposes as well as for plant operation.

Cuba: Miguel Villa, president of the Cuban Society of Engineers and professor at the University of Havana, states that there is little potential water power in Cuba and little fuel to be found there. Power development in Cuba is almost wholly dependent on imported fuels.

Ecuador: Construction of a municipal plant in the city of Quito is expected to take care of probable needs for some years to come, according to Eduardo Salazar, financial counselor at the Ecuador Legation. The needs of the plateau region, on which Quito is situated, will be met by developing water power. Coal and oil must be imported. Plants on the coast will continue to use steam power, since the cost of fuel oil and coal is low.

Holland: Ir. Wouter Cool states that there has been little need of interconnection of power plants in Holland, since fuel costs and plant efficiency are about the same throughout the country. Mr. Cool states that rural electrification has been carried farther in Holland than in any other European country. In the province of North Holland all farms have been electrified. In the province of Gelderland, 75 per cent of the farms are electrified. Good progress is being made in the other provinces.

Ireland: Richard Browne, chairman of the Electric Supply Board, states that an important factor in building up power use in Ireland is the use of small electric heaters in houses which, because of the mild climate, are not furnished with central heating. The principal efforts at present are being directed toward increase in domestic use of electricity. Service is now being furnished to 240 towns by the system operated by the Electric Supply Board. An average of 30 towns will be added each year for several years to come, Mr. Browne believes. Development of the power resources of the Rivers Liffey and Bann are contemplated in the future.

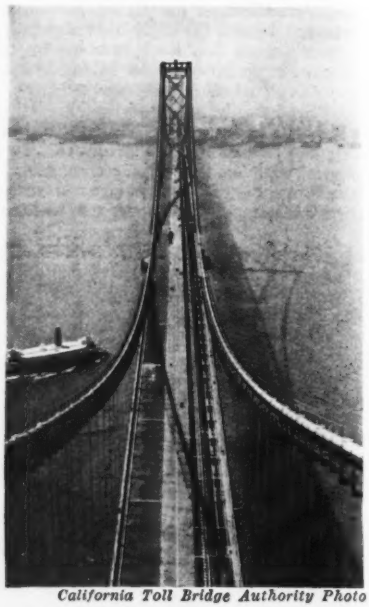
Japan: Japan is finding rich oil deposits in Manchukuo, western Formosa, and in Japan itself, according to engineer-commander Ryuicho Enomoto, Imperial Japanese Navy. At present more than 2,000,000 barrels of oil are being taken from the combined fields annually. Water power possibilities in Japan are also large.

Although electric lighting is used in over 90 per cent of the homes in Japan, members of the Japanese delegation are convinced that adoption of household appliances will be slow. Growth of the electric load there will be almost entirely due to industrial demands. This is increasing rapidly and will be met by the construction of hydro and steam plants. Since the rivers freeze in the winter, enough steam capacity must be maintained to take over the entire load in that region. Japan has little surplus power at present and must proceed immediately with the construction of new plants.

Lithuania: Construction of a 30,000 hp. project on Memuas River is expected soon by S. Kolupila, professor of technology at the University of Kaunas. This is the one large source of water power in the country, he says. There are a number of sites in the country where small installations could be made to advantage.

Norway: Out of a population of 2,900,000 persons, 2,080,000 live in homes supplied with electricity. Electricity is widely used for heating and cooking; only a slight decrease in rates would be necessary to make electricity the main reliance for residential heating. Industrial use of electricity is increasing rapidly. Large uses of electricity are anticipated in the nitrogen fixation and the aluminum and iron alloy industries. Eighty-five per cent of Norway's water power resources are still undeveloped.

Poland: An annual increase of 15 per cent in power consumption is expected in Poland, according to Henryk Hubich.



California Toll Bridge Authority Photo

BAY BRIDGE NEARS COMPLETION

With paving complete on the East Bay crossing and 60 per cent complete on the West Bay crossing, dedication of the San Francisco-Oakland Bay bridge on Nov. 12 is now assured. At that time the entire upper deck and that portion of the lower deck intended to be used by trucks will be thrown open to traffic.

Although plans for interurban traffic are progressing, agreement among the three companies that will operate rolling stock over the bridge is necessary, and extensive terminal facilities must be constructed. The present plan is to call for bids on some of the rail facilities late this fall, but interurban traffic is not expected to be in operation until the summer of 1938, almost two years hence.

A 100,000 hp. plant is now under construction, and another project of 40,000 hp. will be started within the next three years. The total water power resources of the country are estimated at 3,200,000 hp.

Sweden: Sweden is now completing a trunk line that will connect all government owned power stations, W. Borgquist, chief director of the Royal Board of Waterfalls, states. During the past three years power production has increased 30 per cent. Great progress has been made in the electrification of state railroads, and Mr. Borgquist expects that all of these will be electrified in the near future. Rural electrification has been extended to 65 per cent of the cultivated area; most of this power is produced by the government and sold

through cooperatives. Gas is largely used in the cities for cooking, but in the smaller towns electricity is widely used for domestic purposes.

Switzerland: Increase in power development in Switzerland must await greater outlets for Swiss exports, according to Paul Niessen, chief engineer of the supervising board of electric plants and installations. Two power plants are now under construction with a combined capacity of 200,000 hp., which will be completed by the end of next year. Present power output for Switzerland is sufficient to take care of her needs for the next two or three years. Out of potential water resources of 10,000,000 hp., 4,000,000 hp. has been developed.

U.S.S.R.: B. F. Prosin, engineer-economist of the Amtorg Trading Corp., states that the electrical generating capacity in Russia has increased from 1,398,000 kw. in 1925 to 6,880,000 kw. in 1935. About 70 per cent of power consumption is for industrial purposes. At present hydroelectric stations provide about 19 per cent of the total production of electricity; fifteen hydroelectric stations are now under construction with an aggregate capacity of more than 1,000,000 kw. During the second five-year plan, 79 steam-electric stations with an aggregate capacity of about 5,300,000 kw. will be under construction.

Pennsylvania Flood Damage

The value of physical property destroyed in the state of Pennsylvania in the floods of last March was $212,535,000, according to a survey made by the state director of the National Emergency Council. The report states that damage to business and industrial property amounted to $102,378,489. The damage to houses and personal property, the second largest item, was $46,045,260. The loss to the railroads was $12,200,000. The state lost, $5,578,227 in state highway bridges and roads washed out. There was $10,000,000 damage to mines and mining property.

The survey also shows that 80 persons were killed and 2,822 injured in the floods; 2,800 houses and other buildings were destroyed, and 55,000 houses were damaged.

Power Generation Begun In Plant at Boulder Dam

The first regular power generation at Boulder Dam began on Sept. 11 when President Roosevelt pressed a key in Washington as part of the ceremonies at the World Power Conference.

Only one station service unit of 3,500 hp. capacity went into action on Sept. 11. Large scale generation will begin on Oct. 9 when the first main generator will go into service. The present installation includes four of the ultimate fifteen generators of 115,000 hp. capacity, one of two 55,000 hp. units, and one of two 3,500 hp. station units. The first power will go to Los Angeles.

Start of the first station unit in the power plant also marked the virtual completion of the penstock contract of the Babcock & Wilcox Co. The 30-ft. diam. penstocks are the largest ever built and tests under an 800-ft. head, one and one-half times the maximum operating head, have proved their practicability.

The contract for the penstocks was awarded July 9, 1932 and called for completion July 7, 1938. Completion, therefore, is far ahead of schedule, as was the case in the main contract of Six Companies, Inc. The Babcock & Wilcox bid was $10,908,000, but added work will increase the total payment by about $1,000,000.

SOCIETY CALENDAR

PUBLIC WORKS CONGRESS, joint meeting, AMERICAN SOCIETY OF MUNICIPAL ENGINEERS AND INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, Toronto, Ont., Sept. 28-30.

CANADIAN INSTITUTE ON SEWAGE AND SANITATION, Royal York-Hotel, Toronto, Oct. 1-2, 1936.

INTERNATIONAL CONGRESS OF THE BUILDING OF STRUCTURES ABOVE GROUND, Berlin, Germany, Oct. 1-8.

INTERNATIONAL CONFERENCE ON STEEL CONSTRUCTION, Berlin, Germany, Oct. 2-7.

INTERNATIONAL ASSOCIATION FOR BRIDGE AND STRUCTURAL ENGINEERING, second congress, Berlin, Germany, Oct. 1-11.

NATIONAL SAFETY CONGRESS, annual meeting, Atlantic City, N. J., Oct. 5-9.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS, annual convention, Washington, D. C., Oct. 12-13.

AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting, Pittsburgh, Pa., Oct. 13-17.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual meeting, Knoxville, Tenn., Oct. 19-21.

AMERICAN WELDING SOCIETY, annual meeting, Cleveland, Ohio, Oct. 19-23.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, New Orleans, La., Oct. 20-23.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual convention, White Sulphur Springs, W. Va., Oct. 21-23.

HIGHWAY RESEARCH BOARD of the NATIONAL RESEARCH COUNCIL, annual meeting, Washington, D. C., Nov. 18-20.

AMERICAN WATER WORKS ASSOCIATION, ROCKY MOUNTAIN SECTION, Denver, Colo., Sept. 21-23.

NEW ENGLAND WATER WORKS ASSOCIATION, annual convention, New York, N. Y., Sept. 22-25.

AMERICAN WATER WORKS ASSOCIATION, NEW JERSEY SECTION; NEW JERSEY WATER WORKS ASSOCIATION; and the SOUTH JERSEY ASSOCIATION OF WATER SUPERINTENDENTS; joint meeting, Atlantic City, N. J., Oct. 23-24.

CENTRAL STATES SEWAGE WORKS ASSOCIATION, annual meeting, Indianapolis, Ind., Oct. 29-30.

EXAMINATIONS for registration as Engineers, Land Surveyors and Architects will be held as follows:

NEW YORK STATE, examination for professional engineers and surveyors, Jan. 25-27, at Albany, Buffalo, New York City and Syracuse. Applications must be filed with the State Education Department at Albany before Nov. 1.

New Canadian Housing Act

The Dominion Government of Canada has instituted a program, modeled after the American FHA, of stimulating construction. The new program constitutes a modification of the Dominion Housing Act; it follows a recommendation of the National Employment Commission of Canada.

The new program contemplates stimulating renovation and modernization of existing housing units by guaranteeing loans from banks for that purpose; construction of low-rental housing projects, in conjunction, in some cases, with slum clearance; and financial assistance to those wishing to build houses. The renovation and modernization program is regarded as being the most important part of the new program, and is expected to create a great deal of employment. About $50,000,000 is available for the work.

Personals

RUMSEY BRADSHAW, city engineer of Paducah, Ky., has resigned.

BRUCE ROQUEMORE, city engineer of Lakeland, Fla., has resigned that position to accept a federal position in Miami, Fla.

RAY L. HARRISON, formerly assistant city engineer of Omaha, Nebr. has been appointed city engineer of Grand Island, Nebr.

W. F. JOHNSON, formerly WPA engineer of the London, Ky. district, has been appointed Kentucky state field engineer.

LELAND H. KIMBALL has been appointed engineer for the Metropolitan Water District of Salt Lake City, Utah.

WILLIAM M. SPANN, who has been acting state director of the PWA in Missouri since March, 1935, has resigned to devote his time to his private practice in Kansas City.

PAUL E. TIGNOR of Baltimore, Md., has been appointed a lieutenant commander in the Civil Engineer Corps of the United States Navy.

KENYON C. VAIL has been appointed provisional materials engineer for the Colorado state highway department to take charge of the testing laboratory being established by the department.

W. R. CRABTREE, WPA office engineer at Portsmouth, Ohio, has resigned to accept an engineering post with the Kinnear Mfg. Co. L. M. RADER, a member of the city engineer's staff, succeeds Mr. Crabtree.

GLENN E. HANDS, has resigned his position as superintendent of the light and water department at Marion, Kans., and is now with the Burns & McDonnell Engineering Co. on the construction of a new water plant at Cincinnati, Ohio.

FREDERICK S. COOK has been appointed Pacific Coast manager with headquarters in San Francisco for Robert W. Hunt Co., engineers, of Chicago. Since 1919 Mr. Cook has been vice-president and secretary of the McCraken-Ripley Co. of Portland, Ore.

Obituary

PROF. DANA P. BARTLETT, of the Massachusetts Institute of Technology, died Sept. 9 at the age of 72. He had taught mathematics at M.I.T. since 1886.

ALPHEUS B. SLATER, a topographical engineer of Bridgeport, Conn., died there on Sept. 9. He was a graduate of Worcester Polytechnic Institute.

FRANK B. MANNING, for many years

superintendent of streets at Fall River, Mass., and recently repair agent of the Massachusetts Department of Public Works, died recently.

EDWIN O. JORDAN, professor emeritus, University of Chicago, founder of the department of bacteriology and hygiene, died Sept. 2 at the age of 70. Dr. Jordan was one of the earliest researchers into water bacteriology.

HENRY L. ZANDER, an engineer of New Orleans, La., died on Sept. 5 at the age of 76. He had served as an instructor in drawing in Toulane University and as parish engineer for Jefferson Parish, and also was connected for many years with the New Orleans Sewerage and Water Board and the Orleans Levee Board.

MAURICE J. MCGRATH, a district engineer for the Utah state road commission, died Aug. 31 in Salt Lake City at the age of 52. Before entering the service of the highway department he had served as an engineer at the Utah Copper Co. mills and as chief engineer for the Chino Copper Co. in New Mexico.

ALBERT R. BAKER, 54, for the past seven years a civil engineer for the Metropolitan Water District of Southern California, died on Sept. 7 in San Marino, Cal. Before joining the water district staff, Mr. Baker was associated with the Hetch Hetchy water project of San Francisco and before that was engineer in charge of the construction of the Alpine dam in California.

CONSTRUCTION STATISTICS FOR THE WEEK

PRIVATE engineering construction awards totalling $30,513,000, the highest volume in more than five years, raise this week's total volume to $56,382,000. Public contracts make up the remaining $25,869,000 of this volume, $5,617,000 in federal awards and $20,252,000 in state and municipal. Corresponding volume for a year ago is: total, $24,746,000; private, $4,159,000; public, $20,587,000; federal, $7,779,000 and state and municipal, $12,808,000.

Commercial buildings, principally apartment houses in New York City, break volume records for more than five years for this class of work with a total of $21,031,000 for the week. Industrial building awards are up to $8,183,000. Streets and roads awards are also higher at $10,635,000, waterworks at $3,525,000 and bridges at $2,393,000. Other classifications making up this week's volume include: public buildings, $4,416,000; sewerage, $570,000; earthwork, drainage, $2,986,000; unclassified, $2,643,000.

The larger awards for the week include: factory, Post Products Division, General Foods Corp., Battle Creek, Mich., $1,500,000; blast furnaces, Corrigan-McKinney Steel Works, Cleveland, O., $600,000; plant improvements, Tubize Chattillon Corp., New York City, at Rome, Ga., $2,800,000; two 6-story apartments for S. Cohen, separate contracts, Kew Gardens, N. Y., $700,000; 6-story apartment, 902 41st St. Corp., Flushing, N. Y., $500,000; 1st unit, 25 dwellings, day labor, Chanin Organization, Hempstead, N. Y., $1,000,000; group dwellings, day labor, Garden City Terrace Co., Mineola, N. Y., $500,000; 6-story apartment, Greystone Ave. and 240th St., Corporation, c/o M. Finelite, New York, N. Y., $750,000; Chemical building for Medical Center, Jersey City, N. J., $1,370,000; highways, Michigan, $965,000; Oklahoma, $635,000; Illinois, $947,000; South Dakota, $645,000; Iowa, $517,000; Ohio, $561,000; Washington, $602,000; bridges, Illinois, $426,000; Hayfield Pumping Plant, Metropolitan Water District Los Angeles, Calif., $1,331,000; 1,000 ft. impounding dam, Birmingham, Ala., $1,685,000; dredging 3,983 cu.yd. from St. Johns River, Jacksonville, U. S. Engineers, Fla., $1,154,000.

New capital for the week is $8,624,000 in state and municipal bond sales, $1,099,000 in corporation security sales for construction purposes and $25,541,000 in PWA allotments.

CONTRACTS

(Thousands of Dollars)

	Weekly Average Sept. 1935	Prev. 4 Weeks	Week Sept. 17 1936
Federal Government	$9,191	$10,999	$5,617
State and Municipal	15,856	23,060	20,252
Total public	$25,047	$34,059	$25,869
Total private	3,663	8,624	30,513
Week's total	$28,710	$42,683	$56,382
Cumulative to date: 1935	$989,286,000	1936	$1,669,618,000

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

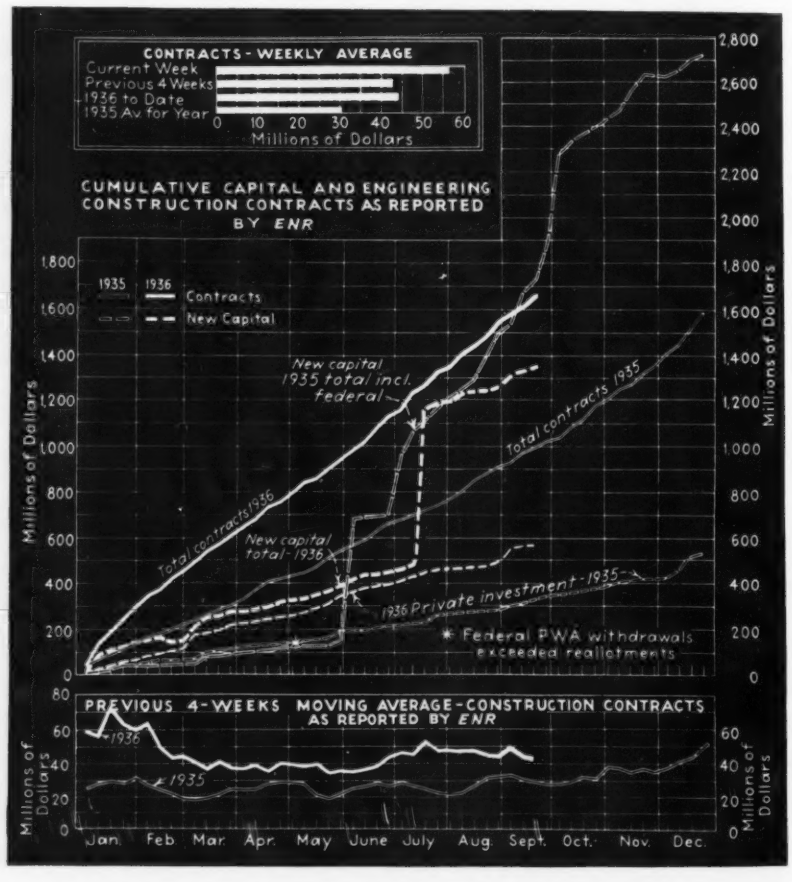
1936	Week Sept. 17	Cumulative
State and municipal	$8,624	$362,467
PWA non-federal	25,541	80,746
RFC loans	....	26,663
Corporate issues	1,099	201,476
PWA loans, Private	....	—1,665*
Total Non-Federal	$35,264	$669,687
Federal	....	691,237
Total new capital	$35,264	$1,360,924
Cumulative to date: 1935	$1,723,996,000	1936 $1,360,924,000

*Bond sales in this classification exceed reallotments during current year.

Note: These figures include private bonds and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities. RFC direct purchase of bonds for "self liquidating" projects, and 25 per cent of WPA construction appropriations.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Sept., 1936	208.10	100.63	Aug., 1936	199	87
Aug., 1936	208.10	100.63	July, 1936	188	82
Sept., 1935	195.10	93.82	Aug., 1935	140	61
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1936 to Date
1935 Av. for Year
0 10 20 30 40 50 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1935 1936
Contracts
New Capital
New capital 1935 total incl. federal
Total contracts 1935
Total contracts 1936
New capital total - 1936
1936 Private investment - 1935
* Federal PWA withdrawals exceeded reallotments
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY ENR
1936
1935
Jan. Feb Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

Construction Equipment and Materials

Osgood ⅜ yd. Shovel

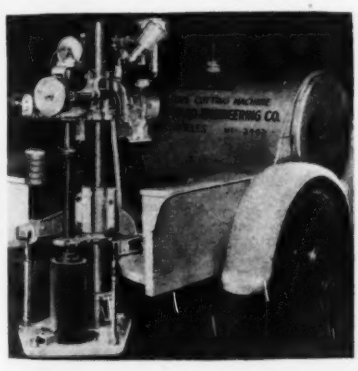
The Osgood Co. has announced the Invader, a ⅜ yd. chain crowd shovel which is convertible to dragline, clamshell, crane, backhoe, or skimmer service and which is furnished either crawler or truck mounted. The Invader weighs 22,800 lb. The machine has four travel speeds giving a range of from 1 to 4 miles per hour, and has a swing speed of 5 revolutions per minute. It is furnished powered with either a 6 cylinder gasoline or diesel engine or an electric motor.

It is said that special attenion has been given to placing the controls in a position to minimize the effort necessary in running the machine and that the clutches and brakes may be engaged with very slight effort.

Core Cutter

Concore, a device developed by the Frank L. Howard Engineering Co. of Los Angeles, is a machine to take test cores from concrete. The machine is available in two assemblies, paving and portable. The paving type, shown in the illustration, is mounted on a trailer equipped with a 108 gal. water tank, tool and specimen boxes, and a bracket for carrying the machine.

The machine is operated by lowering the column through the trailer bracket and placing the steady-rest base against the pavement. The base is equipped with adjusting screws and hardened steel pins which seat themselves into the pavement. The machine is powered with a 4 hp. gasoline motor. A water pump is provided which forces the water from the tank through the drive shaft to supply a cutting fluid to the teeth. The teeth, which are attached to the core barrel in a fixed position, are made of a tungsten carbide product with a hardness of 9.5 on Moh's scale. The machine will cut cores of 2, 4, 6, and 8 in. diameter.



The machine is also furnished, not on the trailer, as a portable unit. The portable unit is identical with the paving unit except that no water tank or pump is provided and that the motor is furnished in either 2 or 4 hp. and either gasoline, electric or air operated.

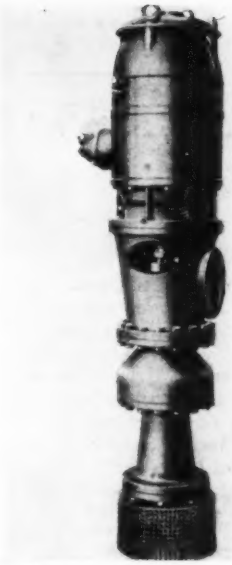
New Equipment in Brief

Drafting Machine—The drafting machines manufactured by the Drafto Co. of Cochranton, Pa., are now equipped with detachable engineering scales graduated in tenths of an inch on one edge and in fiftieths on the other. Inking edges in 6 in. and 10 in. lengths have also been added. A new machine on the same lines as their present drafting machine but equipped to handle sheets 18 in. by 24 in. has also been announced by the Drafto Co.

Wrenches—For use on trucks and heavy industrial machinery, Bonney Forge & Tool Works has added three new sizes to its line of socket wrenches. The new sizes are to fit 1½ in., 1⅝ in. and 2 in. American standard bolts and nuts.

Caulking Gun—Calbar Paint & Varnish Co. sell a loading cartridge containing a pint of their Caulk-O-Seal caulking compound. The cartridge is a metal cylinder with a fiber plunger cap in one end. The plunger of the gun presses against the cap, and ejects the caulk, as the trigger is operated. This cartridge fits the new Albion cartridge gun, and can be made to fit any of the older type Albion guns by substituting a metal plunger for the leather plunger.

Excavator—The new model of the ¾ yd. P&H excavator is built of high-tensile steel by electric welding. The frame, instead of being a unit casting is welded of structural steel sections. The machine is equipped with standard tractor crawlers.



INTENDED ESPECIALLY for dewatering cofferdams, this vertical turbine pump is built by the Worthington Pump & Machinery Corp. of Harrison, N. J. The motor at the top is fitted with a stainless steel shaft, is in a weatherproof mounting, and is grease lubricated to prevent leakage when the pump is not in a vertical position. The impellers are of bronze, as are the intermediate bushings; the bushings can be furnished in special materials when the nature of the water demands it. The pump is furnished in capacities ranging up to 10,000 gal. per minute and in ratings for heads of 20 to 60 ft.; motor sizes vary from 5 to 250 hp.

Recent Publications

• The **Ahlberg Bearing Co.**, of Chicago, issues its new catalog of *Pillow Blocks and Ball Bearings* in loose leaf form. Some tables and formulas for bearing computations are given. • **The International Nickel Co.**, of New York City, in *Bulletin P-1*, describes the properties and uses of a variety of types of heat treated wrought nickel alloy steels.

• Specifications and pictures of recording thermometers manufactured by the **Republic Flow Meters Company** of Chicago are included in their *Data Book No. 210.* • *Lower Piping Costs With Shielded Arc Welding* is a handsomely printed 12-page booklet issued by the **Lincoln Electric Co.**, of Cleveland, Ohio. • The **Austin-Western Road Machinery Company**, of Aurora, Ill., describes their Roll-A-Planes and road rollers in *Bulletin No. 1614.* • The type K ¾ yd. excavator is described in *Catalog No. 1112* of the **Insley Manufacturing Corporation** of Indianapolis, Ind. • Suggestions for the use of Reflecto-strip and Vis-I-Tec road markers are offered in bulletins of the **Traffic Equipment Corporation** of New York City. • *Photo-Micrographic Equipment*, issued by the **Bausch & Lomb Optical Co.**, of Rochester, N. Y., includes a brief discussion of the principles of photo-micrography and a catalog of available equipment.

• Design data and blueprints of a *Steel Sedimentation Basin With an Internal Spiral Baffle* are given in a mimeographed pamphlet offered by the **Pittsburgh-Des Moines Steel Co.** • A pioneer effort, made in 1924, toward keeping Minnesota roads open through the winter is described in *The Romance of Open Roads*, an attractive booklet published by the **William H. Ziegler Co.** of Minneapolis, Minn.

Current Construction Unit Prices

Dam No. 21, Mississippi River

CONSTRUCTION of dam No. 21 is under way on the upper Mississippi River, 2 miles below Quincy, Ill., contract being awarded the McCarthy Improvement Co. on July 28, 1936. The dam forming a part of the navigation development of the upper river will be of the roller gate type, 2,957 ft. long, with three 100x20-ft. roller and ten 64x20-ft. tainter gates, a 200-ft. storage yard and 1,400 ft. of submersible earth dike. The construction is under the supervision of the U. S. Engineer Dept., Rock Island office, and is scheduled for completion within 730 days, with minimum hourly wage rates stipulated as $1.20 for skilled and 50c. for common labor.

Nine bids were received for the work with a range of $807,000 between the high and the low proposals. The following tabulation lists the total and unit bids of the three low bidders: (A) McCarthy Improvement Co. (contract) Davenport, Ia., $2,422,132; (B) Warner Construction Co., Chicago, Ill., $2,481,820; (C) S. A. Healy Co., Chicago, Ill., $2,563,300.

DAM NO. 21, UPPER MISSISSIPPI RIVER

Item	A	B	C
1. Cofferdam—1,123 lin.ft.	$310.00	$233.00	$265.00
2. Clearing—total	2,000	2,490	2,500
3. Excavation, common—45,000 cu.yd.	.60	.50	.47
4. Excavation, dredged—150,000 cu.yd.	.40	.30	.50
5. Excavation, topsoil—63,000 cu.yd.	.40	.65	.233
6. Common fill—10,500 cu.yd.	.40	1.21	.40
7. Topsoil fill—8,000 cu.yd.	.65	1.11	1.30
7a. Dike embankment—215,000 cu.yd.	.25	.17	.25
8. Piling, vert. round timber—165,200 lin.ft.	.65	.51	.70
9. Piling, concrete—2,900 lin.ft.	4.00	3.90	3.00
10. Piling, steel sheet, type A—69,500 sq.ft.	1.30	1.37	1.39
11. Piling, steel sheet, type B—18,500 sq.ft.	1.35	1.32	1.40
12. Piling, steel sheet, type C—79,000 sq.ft.	.52	.83	1.10
13. Pile load tests—5, each	400.00	360.00	400.00
14. Timber, white oak—3 M.B.M.	200.00	286.00	200.00
15. Timber, soft, plain & creosoted—42 M.B.M.	150.00	168.00	180.00
16. Stone protection, derrick—12,100 cu.yd.	4.00	4.14	4.45
17. Stone protection, 1 & 2 Man—13,000 cu.yd.	2.35	3.20	4.55
18. Stone protection, riprap—12,000 cu.yd.	2.68	3.13	4.20
19. Stone protection, crushed, gravel—11,500 cu.yd.	1.88	3.22	3.90
19a. Stone protection, stored—5,000 cu.yd.	3.00	3.18	3.50
19b. Stone protection, rehandled—5,000 cu.yd.	1.20	1.36	1.20
20. Concrete, Cl. A—875 cu.yd.	25.00	24.00	30.00
21. Concrete, Cl. B—40,000 cu.yd	12.21	12.75	12.50
22. Concrete, slushing—2,500 cu.yd.	7.50	14.00	10.00
23. Steel, struct. service bridge—1,615,000 lb.	.061	.075	.082
24. Steel, struct. tainter gates—1,835,000 lb.	.08	.08	.085
25. Steel, struct. roller gates—917,500 lb.	.09	.096	.088
26. Steel, struct. misc.—756,000 lb.	.085	.087	.086
26a. Steel, struct. manganese—262,000 lb.	.11	.106	.097
27. Steel, struct. chromium—87,500 lb.	.34	.113	.112
28. Steel, conc. reinf.—1,300,000 lb.	.04	.05	.0445
29. Steel, corr. resisting—26,500 lb.	.60	.85	.80
30. Forgings, steel—304,000 lb.	.15	.11	.112
31. Forgings, nickel steel—2,875 lb.	.60	.30	.28
32. Forgings, chromium steel—12,700 lb.	.50	.165	.15
33. Castings, steel, grades 1 to 3—275,000 lb.	.13	.195	.177
34. Castings, nickel steel—30,000 lb.	.60	.26	.24
35. Castings, iron—1,000 lb.	.11	.19	.195
36. Bronze—7,450 lb.	.60	.80	.70
37. Copper—300 lb.	.60	.70	.625
38. W. I. pipe, bl. std. 6 in.—420 lin.ft.	2.30	4.25	3.50
39. W. I. pipe, bl. std. 3 in.—380 lin.ft.	1.50	1.90	1.80
40. W. I. pipe, bl. std. 2 in.—32 lin.ft.	2.00	1.80	1.10
41. W. I. pipe, bl. std. ¾ in.—335 lin.ft.	.50	1.00	.80
41a. Corrugated pipe, 12 in.—32 lin.ft.	2.00	2.35	3.00
41b. Corrugated pipe, 10 in—18 lin.ft.	2.00	2.25	3.00
41c. Vitrif. clay pipe, misc.—100 lin.ft.	2.00	2.00	2.00
42. Copper tubing, 1 in—800 lin.ft.	.70	1.15	1.65
43. Fence—10,840 lin.ft.	.40	.42	.30
44. Fiber conduit, 3 in.—850 lin.ft.	.80	.62	.30
45. Rigid metal conduit, 3 in.—130 lin.ft.	3.00	1.90	1.00
46. Rigid metal conduit, 2 in.—10 lin.ft.	3.00	1.10	.60
47. Rigid metal conduit, 1¼ in.—610 lin.ft.	.80	1.00	.55
48. Rigid metal conduit, 1½ in.—20 lin.ft.	.80	.85	.50
49. Rigid metal conduit, 1 in.—210 lin.ft.	.60	.85	.50
50. Rigid metal conduit, ¾ in.—140 lin.ft.	.60	.75	.45
51. Electrical grounding system—total.	350.00	312.00	250.00
52. Crane track, 80 lb.—1,383 track feet	4.00	4.00	3.60
53. Handrail, steel pipe—1,427 lin.ft.	1.60	4.50	4.00
54. Floor gratings, steel—190 sq.ft.	.75	1.10	1.00
55. Rubber seals, moulded—6,500 lb.	.75	.94	.85
56. Roller gate operating mchy.—3, each	21,000	25,000	23,300
57. Roller gate spare parts—total	3,000	350.00	300.00
58. Roller gate mchy. spare parts—total	1,200	10,000	9,000
59. Roller gate opert'g house—4, each	4,200	5,225	4,000
60. Tainter gate opert'g mchy.—10, each	16,000	17,000	15,500
61. Tainter gate spare parts—total	1,000	450.00	420.00
62. Tainter gate mchy. spare parts—total	750.00	11,400	10,300
63. Tainter gate heaters—6, each	1,400	800.00	700.00
64. Tainter gate heater spare parts—total	400.00	780.00	700.00
65. Roller gate heaters—3, each	1,600	4,600	1,200
66. Roller gate heater spare parts—total	350.00	1,100	1,000
67. Locomotive crane installation—total	1,500	2,000	1,750
68. Storage yard trucks—6, each	1,100	300.00	250.00
69. Service bridge trucks—2, each	800.00	350.00	325.00

Lock No. 24, Mississippi River

THE CANALIZATION of the Mississippi River proceeds another step with the award of contract in June, 1936, for the construction of Lock No. 24 at Clarksville, Mo., 93 miles upstream from St. Louis. The project, under the supervision of the U. S. Engineer Dept. at St. Louis, Mo., consists of a main lock chamber 110x600 ft., and an auxiliary lock chamber, 110x360 ft. The length of the upper guide wall will be 518.5 ft., the lower, 502 ft., and the main lock and guide walls, 1,941 ft. overall. The height of the upper gate for the main lock is 25 ft., the lower gate 33 ft. and the auxiliary gate 30 ft. The work is scheduled for 450 days completion. Minimum hourly wages are stipulated as $1.10 for skilled and 45c. for common labor.

The following tabulation lists the totals and unit bids of the three low proposals of the seven submitted. (A) Central Engineering Co. (contract) Davenport, Ia., $1,635,789; (B) Kansas City Bridge Co., Kansas City, Mo., $1,642,981; (C) McCarthy Improvement Co., Davenport, Ia., $1,723,462.

LOCK NO. 24, UPPER MISSISSIPPI RIVER

Item	A	B	C
1. Cofferdam—1,422.5 lin.ft.	$232.00	$220.00	$210.00
2. Cofferdam guide wall—518.5 lin.ft.	23.00	50.00	7.00
3. Excavation, common—62,300 cu.yd.	.42	.50	.70
4. Excavation, dredged—26,200 cu.yd.	.40	.30	.20
5. Excavation, rock—31,300 cu.yd.	2.10	2.00	2.25
6. Channeling, rock—34,000 sq.ft.	.90	.80	1.00
7. Fill—81,800 cu.yd.	.25	.30	.10
8. Drilling, grouting, 0 to 10 ft.—3,000 lin.ft.	.50	.50	.40
9. Drilling, grouting, 10 to 20 ft.—2,000 lin.ft.	.55	.80	.60
10. Pressure grouting, cement—750 bbl.	5.50	5.00	4.35
11. Pressure grouting, sand—3,000 cu.ft.	.50	.40	.50
12. Timber, white oak—35.6 M.B.M.	145.00	150.00	160.00
13. Timber, creosoted—3.1 M.B.M.	110.00	150.00	140.00
14. Stone protection, one man—120 cu.yd.	5.75	5.00	3.25
15. Stone, crushed, gravel—123 cu.yd.	3.75	3.50	3.00
16. Concrete, Cl. A—734 cu.yd.	20.00	19.00	20.00
17. Concrete, Cl. B—78,200 cu.yd.	10.33	10.00	11.67
18. Steel, struct. wall—749,200 lb.	.046	.06	.055
19. Steel, struct. gates—801,600 lb.	.075	.08	.071
20. Steel, struct. valve—81,400 lb.	.12	.11	.08
21. Steel, struct. misc.—312,800 lb.	.07	.08	.085
22. Steel, conc. reinf.—747,300 lb.	.045	.05	.05
23. Steel, non-corroding—8,000 lb.	.65	.60	.56
24. Steel, struct. nickel—1,700 lb.	.30	.25	.50
25. Steel, struct. chromium—7,430 lb.	.10	.25	.27
26. Forgings, steel—162,100 lb.	.125	.14	.16
27. Forgings, nickel steel—7,420 lb.	.25	.25	.25
28. Castings, steel, grade 0—26,850 lb.	.12	.15	.16
29. Castings, steel, grade 1 to 3—73,800 lb.	.14	.18	.13
30. Castings, alloy, nickel—7,000 lb.	.22	.20	.17
31. Castings, iron—27,000 lb.	.08	.10	.08
32 Bronze, brass—3,300 lb.	.45	.60	.60
33. Copper—4,600 lb.	.68	.60	.50
34. Non-ferrous metals—3,260 lb.	.22	.25	.28
35. Pipe, steel, black, std.—500 lin.ft.	.45	1.00	.80
36. Pipe, steel, black, 3 in.—10 lin.ft.	1.00	1.25	2.60
37. Pipe, cast iron, 24 in.—10 lin.ft.	10.00	10.00	25.00
38. Pipe, w.i. galv. 4 in.—13 lin.ft.	2.50	1.60	3.50
39. Pipe, w.i. black, 6 in.—34 lin.ft.	3.00	2.50	2.00
40. Pipe, sewer, 24 in.—580 lin.ft.	3.35	3.50	3.55
41. Pipe, sewer, 30 in.—474 lin.ft.	4.25	5.00	4.75
42. Conduit, fibre, 3 in.—57,100 lin.ft.	.35	.35	.30
43. Conduit, fibre, 2 in.—7,870 lin.ft.	.30	.25	.25
44. Conduit, metal, 2 in.—924 lin.ft.	.75	1.00	.75
45. Conduit, metal, 1¼ in.—82 lin.ft.	.60	.75	.70
46. Conduit, metal, 1 in.—26 lin.ft.	.50	.50	.65
47. Electrical grounding system—total.	565.00	700.00	500.00
48. Handrail, galv. steel—988 lin.ft.	2.45	2.80	2.00
49. Floor grating, steel, Cl. B—1,490 sq.ft.	1.00	1.25	.90
50. Floor grating, steel, Cl. D—5,000 sq.ft.	1.00	1.50	1.00
51. Rubber seals, molded.—980 lb.	2.00	1.20	1.00
52. Rubber fabric seals, 5 in.—50 lin.ft.	.70	1.00	.50
53. Tile gage—97 lin.ft.	7.50	7.00	6.00
54. Operating gates, miter, complete—2, each	7,100	7,500	8,000
55. Operating gates, upper miter, complete—2, each	6,600	7,000	7,500
56. Operating valves, tainter—4, each	4,600	5,000	5,000
57. Mitre gate machinery drains—4, each	35.00	100.00	60.00
58. Gate valves, wedge 4 in.—2, each	125.00	50.00	50.00
59. Gate valve, sluice—total	375.00	300.00	150.00
60. Gasoline tank pit drain—1, each	35.00	100.00	60.00
61. Water service lines—total	1,350	3,500	1,500
62. Tow haulage guides—total	860	1,500	600
63. Temporary construction bldgs.—total	3,750	3,500	3,500